CARE OF THE Surgical Patient

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Surgical Patient



INCLUDING PATHOLOGIC PHYSIOLOGY
AND PRINCIPLES OF DIAGNOSIS
AND TREATMENT



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Preface

This book is not a textbook of surgery It is intended to serve the special purpose of providing a ready guide for the over all care of the surgical patient It epitomizes the essential facts required for an in telligent understanding of surgical diseases, and the basic principles involved in their diagnosis and treatment

A mature surgeon, like any other responsible medical practitioner, deals with his patient as a whole human being, who is often bur dened with concomitant non surgical ailments, possessed of a per sonality and an individual orientation toward his illness All of these matters bear, in varying degree, upon the manner in which he will manage the surgical complaint, none can be ignored If he classifies and treats them as accessory nuisances, he will do so not only at his own peril but, what is far worse, at his patient's peril While he should not be expected to be able to deal expertly with these matters, he is not likely to serve the patient's welfare without a reasonable famili arity with them Hence it is not inappropriate to include in this volume a brief discussion of disorders that are usually the concern of the internist and the specialist in more restricted fields

The scope of the book is sufficiently broad to be useful not only to those interested in surgery, but to all physicians who may deal in one way or another with surgical patients

Since memory is treacherous, a variety of factual data which the busy physician must use "while he runs" is provided

While surgical technic is not discussed, brief reference is made where the patient's care hinges on the surgical procedure utilized

The material is presented in much the same manner as one might discuss the subject in an informal lecture or seminar to students or graduates in training The substance of each section represents the considered opinion of members of the staff of a teaching hospital as to what constitutes the best standards of practice Only an occasional reference is made to the authority for a statement The writer is con fident that there are few statements which sound evidence, borrowed freely from the literature,* or the lesssons of experience will fail to sup port I can best express my indebtedness to others in the words of Professor Earnest Hooton who says in his preface to "Up From the Ape," "I have freely utilized the thoughts and investigations of many

* Physical Signs in Clinical Surgery Hamilton Bailey 1st Ed Wm Wood and Co Extracellular Fluid James Gamble Harvard University Press Abdominal Surgery in Infancy and Childhood Wm Ladd and Robert Gross W B Saunders Co

scientists If I have not given them credit specifically, it is not be cause I wish to appropriate their glory, but rather because I have as similated so completely the nourishment which they have provided that identification of the raw materials has become difficult So I gratefully acknowledge my indebtedness to anyone who may think that he reads in this book an exposition of his own ideas, however distorted their reflection "

I am deeply grateful to my colleagues who assisted in the compila tion of this volume —

Dr Benjamin Banks for most of the chapters on Diseases of the Gastro intestinal Tract and Liver
Dr Samuel Beaser for the section on Diabetes Mellitus
Dr Grete L Bibring for the section on Psychiatric Disorders
Dr Alvin Cahan for the chapter on Oxygen Therapy
Dr Sidney Cohen for assistance in the chapter on Surgical In fections
Dr Harry Derow for assistance in the section on Renal Dis orders
Dr Howard Frank for the chapters on Burns and Thoracic Disorders
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Dr Samuel Gargill for the section on Endocrine Disorders
Dr Samuel Gilman for the chapter on Anesthesia
Dr Samuel Hanflig for most of the section on Fractures and Dislocations and the chapter on Orthopedic Surgery
Dr Richard Hoffmann for the section on Common Skin Disorders
Dr Mark Lesses for the chapter on the Blood Bank
Dr Arthur Linenthal for the tables on Special and Specific Medication
Dr Samuel Lowis for the section on Neurosurgical Disorders
Dr S Richard Muellner for part of the chapter on Urologic Disorders
Dr Leonard Nathan for the section on Dental Disorders
Dr George Pike for the chapter on the Anemias and Blood Dyscrasias
Dr Arnold Starr for part of the chapters on Peripheral Vas cular Disease and Surgical Infections
Dr Malvin White for the chapter on Plastic Surgery
Dr Louis Wolff for the section on Cardiac Disorders
Dr Louis Zetzel for part of the chapter on Nutrition in Sur gical Patients

Since I have freely edited the manuscripts of my collaborators, supplementing, revising or deleting as appeared appropriate to me, I must, of course, accept final responsibility for the accuracy of the text

My thanks are due to Drs Felix Fleischner, Howard Frank, Arnold Segel, Louis Hermanson and M Leopold Brodny, who provided additional invaluable assistance Finally, I am deeply indebted to my secretary, Miss Evelyn Avruch, for devoted and tireless work on the manuscript

JACOB FINE

March, 1949

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SECTION I

General Considerations

CHAPTER I

USEFUL HINTS IN SURGICAL DIAGNOSIS

THE UNCONSCIOUS PATIENT

If the patient is pale, look for hemorrhage or a cardiac disorder If the skin is cherry red, suspect carbon monoxide poisoning If the skin is blue, suspect pulmonary injury or infection, head injury or epilepsy If the skin is dry, look for diabetic acidosis (acetone breath, rapid Kussmaul breathing) Extreme restlessness suggests delirium tremens Cheyne Stokes respiration or irregular breathing suggests brain injury, uremia, pneumonia or cardiac disease A slow pulse suggests increased intracranial pressure or heart block A rapid shallow pulse suggests barbiturate poisoning Unilateral flaccid paralysis indicates hemiplegia Rising blood pressure indicates cerebral injury A fall in blood pressure and a rising pulse indicate shock and a poor prognosis Convulsive movements indicate tetany, hypoglycemia, epilepsy, brain tumor or uremia Hysteria, narcolepsy or catalepsy should be considered One dilated fixed pupil signifies ipsilateral brain injury Pinpoint pupils indicate morphine poisoning or intraventricular hemorrhage The eye grounds will indicate signs of malignant hypertension or brain tumor A stiff neck suggests meningeal irritation from blood or inflammation If pressure on the supraorbital nerves produces no response or the corneal reflex is absent, the coma is deep The urine analysis will help in differential diagnosis Lumbar puncture may be of value if there is no papilledema

REGIONAL SIGNS AND SYMPTOMS

The Head

Scalp wounds do not gape unless the galea has been divided A swelling in the scalp moves on the skull A hematoma beneath the pericranium does not extend beyond suture lines and feels like a depressed fracture

In *acute head injury* a gradually declining pulse rate or increasing unconsciousness or restlessness signifies increasing intracranial pressure, one fixed dilated pupil signifies greater damage on that side bleeding from the ear in the absence of local laceration signifies *basilar fracture*, subconjunctival hemorrhagic extravasa

tion limited to the orbital margins indicates fracture of the anterior cranial fossa and rhinorrhea signifies *fracture of the ethmoid plate* If the patient lies curled up, with his face turned from the light, eyes closed, if he is resentful of being aroused or if he is abusive and irritable, *cerebral irritation* is likely

The Mouth and Face

Examine the teeth for malocclusion, loose or carious teeth Look at the gums for pyorrhea and lead line Look at the tongue A *smooth red tongue* with loss of papillae indicates nutritional deficiency, a *dry tongue* may mean dehydration If this is so, look for other signs of dehydration (loose wrinkled skin, soft eyeballs, etc) *Pain in the ear* from mouth lesions (e g , cancer) is due to involvement of the lingual nerve, with reference via the auriculotemporal nerve Examine the cervical nodes if there is any suggestion of neoplasm in the mouth

Suppuration of the salivary ducts is accompanied by inflammation of the orifice of the ducts A fine nasal probe inserted in the duct may grate upon a *calculus*, if present If Wharton s duct is blocked by a calculus, saliva will not exude from that duct when a pinch of salt is placed in the floor of the mouth, previously dried with a swab An *enlarged submaxillary gland* can be diagnosed by palpating a continuous intrabuccal and cervical swelling This is determined by grasping the gland between a finger inside the mouth and the fingers of the other hand beneath the jaw Enlarged lymph glands in this area do not project into the floor of the mouth *Stenson's duct* can be felt one finger's breadth below the zygoma

Preauricular adenitis may be present in inflammation of the eyebrow, lids or temporal area The swollen gland lies just anterior to the tragus

Fracture of the malar bone can be detected by holding two throat sticks vertically from the prominences of the malar bones at the outer edge of the orbits The angle will be different on the two sides

Proptosis of the eyeball in the presence of suppuration of the face signifies cavernous sinus thrombosis *Edema of the eyelids* not due to a skin disorder or injury or renal disease suggests thyrotoxicosis

The Neck

To examine the neck stand behind the patient and adjust the head in slight flexion and inclined slightly toward the side being

examined Otherwise the sternomastoid and platysma are not relaxed and interfere with palpation Examine the submental, submaxillary, jugular, supraclavicular and posterior triangle areas for *lymph glands* Palpable glands in the posterior auricular region and/or the posterior triangle suggest disease of the scalp *The great cornu of the hyoid* in elderly patients may simulate a hard gland, but it is well forward of the jugular chain and moves on swallowing To determine the relationship of a mass to the sternomastoid muscle, e g , branchial cyst, have the patient push the chin firmly against the palm of your hand and feel the mass in relation to the muscle with the fingers of your other hand

The *thyroid* moves up on swallowing Grasp the lobes with the index and middle fingers of both hands, your thumbs resting on the nape of the neck Define the lower borders of the lobes during swallowing to see if downward extension reaches substernally Incline the head to one side to relax the sternomastoid in order to feel the rest of each lobe Observe the position of the trachea, below and between the thyroid lobes A mass in the midline arises from either side, unless the pyramidal lobe itself is enlarged

In *hyperthyroidism* the pulse is rapid, a *bruit* may be heard and a *thrill* can be felt over the lobes, the eyeballs may bulge, the upper lids lag on looking down and there is difficulty in convergence

A *thyroglossal cyst* presents between the upper borders of the thyroid gland and thyroid cartilage and lies slightly to one side of the midline It moves upward on protrusion of the tongue

The Breast

Observe the patient sitting up and square The left nipple usually is a little lower than the right Retraction of the nipple or elevation above its normal position signifies recent inflammation or carcinoma, unless it can be accounted for on the basis of an old history of mastitis Feel for a lump with the flat of the hand, taking each quadrant separately You may be helped to locate a small mass in a large breast by asking the patient to point it out Chronic cystic mastitis may present ill defined masses simulating carcinoma Both may exist together

Observe fixation to the skin This is often best observed from the side with the patient leaning forward A mass so fixed is likely to be malignant except when it is directly behind the nipple and is a part of the duct system See if the mass is attached to the pectoral muscles If it is attached, its mobility, especially in the horizontal plane,

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is limited when the muscle is contracted This is done by asking the patient to press her hand firmly against the flank

Examine the axilla and supraclavicular area for palpable lymph glands In the axilla there are four groups of glands, one behind the lateral border of the pectoral muscles, a second at the bottom of the posterior axillary fold (latissimus dorsi), a third in the apex of the axilla and a fourth in the center of the axilla With the patient in the sitting position, let her elbow rest relaxed on your opposing forearm and feel for groups one and four with the fingers of that hand Use your other hand to steady the opposite shoulder Groups two and three are best felt from behind by holding the arm forward with one hand and feeling the glands with the other

Mastitis in adolescent males presents a hard circular lump of varying size behind the nipple

Fractured rib is detected by direct pressure over the fracture site or by the localization of pain by the patient when the examiner compresses the chest anteroposteriorly

The Shoulder Girdle, Arm and Forearm

(See chapter on Orthopedic Disorders)

The shoulder girdle is not seriously injured if the patient can raise his arm vertically above his head If the ends of a ruler can touch the acromion and the external condyle of the humerus, the great trochanter is out of the way and the *joint is dislocated* or the neck of the scapula is fractured If dislocated, the axilla is filled up and has greater girth than the other The patient cannot then put his hand on his opposite shoulder When a patient holds his arm with his other hand, a serious injury is likely A *dropped shoulder* means fracture of the clavicle or injury to the circumflex nerve or a dis location If the *biceps tendon* is torn, there is one lump If the *biceps muscle* is torn, there are two lumps

Damage to the *elbow joint* may be detected if while the fore arm is held at right angles there is distortion of the normal triangle between the epicondyles and the tip of the olecranon

Fracture of the head of the radius is detected by noting its failure to rotate during pronation and supination Palpate the head with the thumb of the hand in which the injured elbow rests

The Wrist

Tenderness in the anatomical snuff box with the wrist in ulnar deviation, suggests *fracture of the scaphoid* If this is so, percussion of the knuckle of the middle metacarpal, with the hand in

radial flexion, will cause pain If the *semilunar is fractured*, this knuckle projects less on this fist than on the opposite one

In wrist injuries, especially from suicidal transverse incisions, test for *median nerve injury* by placing the hand flat on the table, palm up and asking the patient to touch with his thumb a pencil held perpendicularly above it

Ulnar nerve injury prevents the patient from holding a paper firmly between the fingers of the outstretched hand

The Hand

If there is infection, the site of maximal swelling does not locate the pus, but maximum tenderness frequently does In *tenosynovitis* the affected finger is flexed more than the others and tenderness is maximal over the sheath Extension of the involved finger is very painful In *ulnar bursitis* there is maximal tenderness at the intersection of a vertical axis between the fourth and fifth metacarpals and a horizontal axis between the two major creases of the palm In *radial bursitis* the thenar eminence is ballooned out, the distal phalanx of the thumb is flexed and rigid and tenderness is maximal along the flexor pollicis longus In *midpalmar space infection*, the concavity of the palm is obliterated and tenderness is maximal directly over it

The Abdomen

Warm your hands if they are cold The patient lies flat with one pillow under the head, hands to the sides and is told to breathe through the mouth Some patients, however, will not do this without effort and it is necessary to divert them by conversation See that the back is flat on the bed Do not try to examine in Fowler's position Feel the abdomen with the flat of the fingers, not the tips Look at the type of respiration Abdominal expansion is limited in a region of *inflammation* Some masses can be seen better than they can be felt, especially a mass in the stomach, which disappears under the costal arch on expiration In suspected *pyloric stenosis* look for gastric peristalsis It proceeds from left to right

The location of abdominal pain is a highly significant means of localizing disease Pain, either well localized to the midline or radiating bilaterally from the midline is usually of gastro intestinal origin Continuous pain connotes inflammation Colicky pain connotes obstruction or severe localized spasm The level of pain is a clue to the site of disease in the intestine Thus midline pain below the umbilicus, if not arising in the uterus or bladder, signifies disease

in the colon, pain at the umbilicus, or radiating diffusely from it, signifies disease of the small intestine or appendix, and pain above the umbilicus, disease of the stomach, duodenum or upper small intestine

Pain in the midline of extra intestinal origin may arise in retro peritoneal structures situated in the midline Thus, sudden contin uous low midline pain in older individuals, especially if it radiates down one or both lower extremities, suggests dissecting aneurysm of the aorta or an embolus at its bifurcation Sudden severe midline epigastric pain may be due to rupture of a peptic or neoplastic ulcer,

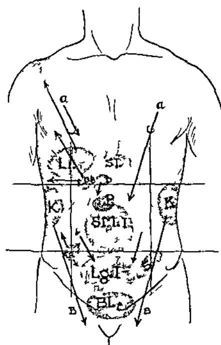


Fig 1 Common sites of pain and pain radiation with acute abdominal disorders St Stomach D Duodenum P Pancreas Sm I Small intestine Lg I Large intestine Bl Bladder K Kidney and ureter S Sigmoid colon G B Gallbladder a–a Pain of thoracic diseases referred to abdomen B–B Pain of ureteral colic referred to thigh and genitals (Livingston Abdominal Cavity and Peritoneum Paul B Hoeber Inc New York.)

but it may also be due to acute pancreatitis In the former case there is little radiation of pain to distant areas, but in acute pancreatitis, radiation to the right or more often to the left occurs and typically, in addition, there is a violent boring continuous pain in the midback at the upper lumbar level Pain due to rupture of a tubal pregnancy or of the spleen will be felt in their respective areas, but may be over shadowed by pain in the left supraclavicular area, because of irrita tion by blood of the left half of the central tendon of the diaphragm Pain in the flanks radiating into the perineum or the scrotum and to the inner aspect of the upper thigh suggests renal or ureteral colic

To distinguish intraperitoneal disease, such as appendicitis, from renal or ureteral pain, the presence of skin hypersensitivity in the ureteral triangle in the thigh will be found of considerable value in favor of a process in the urinary tract Intraperitoneal disease, except for femoral hernia, will not produce this sign

An understanding of the innervation of the abdominal wall is of paramount clinical value in the interpretation of pain reference and of reflex effects from the abdominal and thoracic viscera Since a vertical abdominal incision reflexly irritates more dorsal cord segments than a transverse incision, it produces greater reflex immobility of the diaphragm, costal margins and lung bases Transverse incisions are said to result in less pain, whether at rest or in motion, and in less disturbance of respiratory mechanics

Just as pleuritic pain involving the lower dorsal nerves may be referred to the abdominal wall from the hypochondrium to the lower flank, so heart pain in massive coronary occlusion may be felt in the upper epigastrium by way of the sixth dorsal spinal segment Contrariwise, pain in disease of the biliary tract may produce pain in the region of the lower sternum or xiphoid via the sixth and seventh dorsal spinal segments

Do not expect localized tenderness when *intestinal obstruction* is present or suspected unless there is an associated inflammatory process such as a pericolic abscess or *strangulation* The site of inflammation is not always the site of the obstruction Generalized low grade tenderness, however, may be found in severe distention In simple gastro enteritis generalized tenderness is common and generally diffuse, but seldom severe In old or debilitated patients severe inflammation may be present without tenderness or with only mild tenderness In a vigorous individual rebound tenderness is a strong indication of peritoneal inflammation

In *appendicitis* hyperesthesia in the right iliac fossa and localized pain and tenderness in this area do not always signify that the appendix is in its usual position If it is retrocecal, maximal tenderness may be found in the loin If the appendix is close to the psoas, hyperextending and abducting the thigh may cause pain If you suspect appendicitis, rule out the right lung and kidney and the pelvic adnexa in the female Tenderness of the adnexa is located well below the usual site of the tenderness due to appendicitis Percussion tenderness and rebound tenderness should be well defined and localized to McBurney's point in a typical case of appendicitis

To feel the spleen's lower edge, remember that it lies far more lateral than is generally appreciated If one feels the spleen, it is

enlarged at least by a third A *large spleen* filling the flank still leaves a space between it and the erector spinae muscles A renal mass does not

A *renal mass* is differentiated from an intraperitoneal one by ballottement between the two hands and noting its impingement on the hand behind the flank when pressing quickly and sharply backward with the other hand on the abdomen A renal neoplasm tends to project forward, an abscess or hydronephrosis tends to project backward The sudden appearance of a left varicocele suggests a malignant lesion of the kidney

An abdomen is enlarged because of "fat, flatus, feces, foetus or fluid" or tumor An *ovarian cyst* produces flatness in the center of the abdomen and tympany in the flanks *Ascites* does the reverse In ascites the liver edge or a mass is best defined by quick slight pushing strokes with the fingers The sudden appearance of a small umbilical hernia with or without ascites may be the first sign of malignant disease in the liver

A fixed smooth round epigastric mass is likely to be a *pancreatic cyst*

Mobility of Masses A mass in the abdominal wall, superficial to the anterior rectus sheath, is readily definable in this plane by tensing the abdominal musculature A mass in the musculature or fixed to its fascial investments, such as hematoma, tuberculous abscess or "sarcoid," is rendered immobile by such tensing The same maneuver renders a mass beneath the musculature less accessible and less definable Tensing the rectus muscles is best achieved by having the patient, while lying quite flat, lift the head, not the shoulders, off the pillow Tensing the whole belly wall is best achieved by having the patient blow hard with the mouth closed and the nose pinched tight, or by asking the patient to strain as if at stool Do not ask the patient to make the muscles tight Tell him what to do according to the foregoing instructions

A mass freely movable in the peritoneal cavity is likely to be one attached to a movable structure, such as omentum, small intestine or ovary Masses on a pedicle, of course, may derive from any structure Fixed masses are either inflammatory, attached to the anterior abdominal wall (actinomycosis) or to fixed structures, such as the liver, kidney, pancreas, ascending and descending colon, base of mesentery, etc

Masses at the sites of hernial orifices are readily identified as hernias except for *epigastric* and *femoral hernias* The former is in a characteristic location in the midepigastrium, but is misleading to

the unwary because it frequently is found to one side of the midline, usually to the right, and is so soft and mobile (properitoneal fat) as to be confused with a lipoma in the subcutaneous fat

When palpating the abdomen in a patient who is tender, watch the facial expression It may tell you more than a verbal reply

Never diagnose the nature of a pelvic mass so long as the bladder is not empty

A *pelvic mass and diarrhea* in an acutely ill patient who has not had a recent attack of gastro enteritis often means *pelvic abscess*

Intraperitoneal bleeding produces rigidity and leukocytosis



Fig 2 Tensing the abdominal musculature (Bailey Demonstrations of Physical Signs in Clinical Surgery John Wright and Sons Ltd Bristol England)

Two parallel lines perpendicular to the line corresponding to the root of the mesentery divide the abdomen into three parts, corre sponding to the upper middle and lower thirds of the small intestine

Rectal Examination Never omit a rectal examination It is an essential part of the abdominal examination Patients in bed may be placed in the Sims' position or lithotomy position, but the knee chest position is by far a more satisfactory one for exhaustive inspection of the rectum and sigmoid Look at the external parts Note a fissure in ano or the bluish swelling of a thrombosed hemorrhoid If there is pain on defecation and afterward, if the sphincter is rigid in spite of proper lubrication of the gloved finger, gentleness, mouth breath ing and reassurance, suspect a fissure in ano and use local anesthe sia for exposing the rectal canal

The finger enters by steady firm pressure against the sphincteric ring and one palpates the posterior curve of the rectum with a rotary sweep, full length Then ask the patient to strain in order to force the upper region of the canal down and make a high lesion accessible Then palpate anteriorly the cul de sac and coming down feel the cervix in the female or the prostate in the male A hard mass may be a fecalith—if so, it can be dented and displaced or broken up Do not confuse a tumor with the cervix in the female

Anorectal Disorders *Bleeding* which is not due to disturbances proximal to the internal sphincter such as polyp, ulcerative colitis, peptic ulcer, neoplasm, Meckel's diverticulum, intussusception, thrombosis of mesenteric vessels, etc, is usually due to hemorrhoids Bleeding from hemorrhoids usually occurs only during defecation The bleeding from fissure in ano is only a streak of blood on toilet tissue If the patient is a Negro and there is also a purulent discharge, stricture caused by lymphogranuloma inguinale should be suspected Occasionally rectal prolapse causes bleeding Make sure in a female that the blood is not of vaginal origin

Spasm of the sphincter is due to fissure, ulcer, ischiorectal abscess, cryptitis or fear and anxiety If the latter is responsible reassurance and gentleness will allow the examining finger to negotiate the anal canal If local disease is responsible, it is useless and painful and self defeating to use force Local anesthesia, 2 cc of 1 per cent novocain, introduced through the skin directly into the sphincter will relax the sphincter and permit internal inspection

Tenderness, if present on either side of or posterior to the anal orifice and if accompanied by local signs of inflammation, is nearly always due to ischiorectal abscess Well localized tenderness over the posterior anal commissure is usually due to a fissure, especially if there is a sentinel pile

Pain Dull aching pain is due usually to ulcerating hemorrhoids or carcinoma invading perirectal tissues Throbbing pain, if accompanied by general malaise or constitutional signs of infection, is due usually to ischiorectal pararectal or prostatic abscess Burning pain suggests a cryptitis or a fecal impaction If a nodule has recently appeared on the anal margin and is of a bluish hue, the pain is due to a thrombosed external hemorrhoid

Protrusions from the anal canal include hypertrophied papillae internal hemorrhoids, prolapsed rectal wall pedunculated polyp or lipoma and carcinoma, in that approximate order of frequency

Constipation If of recent origin look for impaction, fissure in ano, a painful thrombosed hemorrhoid or an abscess producing

reflex spasm of the sphincter If all these are absent, suspect ob structing carcinoma, stricture or diverticulitis Carcinoma of the stomach is a not infrequent sole cause of constipation Acute genito urinary disease may also produce reflex effects on the bowel or anal sphincter

Diarrhea If persistent, suspect carcinoma, ulcerative colitis or regional enterocolitis, in that order Carcinoma is especially likely if the diarrhea wakes the patient early in the morning A long history of constipation followed by apparent return to normal function may mean carcinoma A pelvic abscess will also cause diarrhea

Inguinal Hernia Inguinal hernias which descend into the scro tum are nearly always indirect Direct hernias seldom descend into the scrotum A scrotal hernia can be distinguished from a hydro cele by the absence of fullness in the canal in the latter Transil lumination alone does not differentiate hydrocele from a tense distended loop of gut in a hernial sac

With the patient erect and his head to one side, ask him to cough and look for an impulse on coughing from the side of the patient Then feel for an impulse Often it can be seen better than it can be felt If there is doubt, insert the tip of your index finger into the ex ternal ring, reaching for it by invaginating the scrotum and identi fying the spine of the pubis With the finger in the triangular slit of the ring, ask the patient to cough again A normal ring admits only the tip of the little finger In the female one cannot enter the ring If you cannot feel an impulse on coughing when a mass is present and if the mass cannot be reduced in the reclining position, with taxis applied, and if the mass reaches up to the internal ring, it is an ir reducible hernia or, rarely, a hydrocele of the cord The latter moves downward on gentle traction upon the testis *Be cautious in using taxis*—you may do harm with force See if the muscles are firm and well developed or thin and attenuated during contraction of the ob lique and rectus muscles

To distinguish a direct from an indirect inguinal hernia, locate the internal ring (1/2 inch above the middle of Poupart's liga ment) and with a finger compressing it so as to obliterate it, the im pulse and bulge of a reduced indirect hernia will be absent on cough ing, while a direct hernia will bulge forward through Hesselbach's triangle The ring of a direct hernia admits the finger directly back ward

Femoral hernia may be hard to identify In postpartum females pain in this region, radiating downward along the adductor magnus, is sometimes due to abnormal mobility of the symphysis pubis The

impulse of a femoral hernia can often be seen better than it can be felt It must not be confused with a *saphenous varix*, which produces a palpable thrill on coughing, a venous hum with the stethoscope and is accompanied by other varicose veins The bulge of an early hernia is below Poupart's ligament As it grows, becomes obvious and finally incarcerated, it may appear above the ligament but more laterally placed than an inguinal hernia, the bulge of which presents at, below or even medial to the external ring If there is difficulty in differentiating the two, palpate the inguinal canal and see if it is full or empty



Fig 3 Femoral hernia in a female Its relation to Poupart s ligament X–X (DeQuervain Clinical Surgical Diagnosis 4th Ed Wm Wood & Co Baltimore)

When the hernial bulge moves from the area just below the medial third of Poupart s ligament, it travels laterally and upward along the plane of Scarpa s fascia to lie subcutaneously directly over and even slightly cephalad to the midpoint of Poupart's ligament In this stage of development the head of the mass presents a smooth, usually firm contour, often only slightly tender If it is incarcerated it may be mistaken for an inflamed mass of lymph glands or a lipoma, especially when there are no symptoms referable to peritoneal structures, as is often the case if the hernia consists of an empty sac surrounded by a large mass of properitoneal fat A characteristic clinical picture is that of an elderly woman who complains only of a mildly painful or painless lump which has been present for only a relatively short time If the appearance of the lump is associated

with symptoms referable to the gastro intestinal tract, such as nausea, colic, vomiting or constipation, suspect strangulation

Enlarged lymph glands in the groin will often be associated with neoplasm or infection of the perineum, external genitals or lower extremity and usually produce a multilobular instead of a single round hard mass The femoral nodes may also be involved Look at the leg from the toes upward for a focus of infection

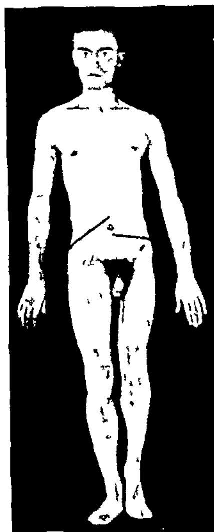


Fig 4 Shoemaker s lines show the great trochanter displaced upward on the left side (Bailey Demonstrations of Physical Signs in Clinical Surgery John Wright and Sons Ltd Bristol England)

The Lower Extremity

(See chapter on Orthopedic Disorders)

Displacement upward of the great trochanter of the femur is best detected by prolonging a line joining it and the anterior superior spine across the abdomen This line should cross at or above the um

bilicus If below, the trochanter is displaced upward This indicates *fracture of the hip* Fracture of the femoral neck produces flaccidity of the tensor fascia lata Flexion of the hip in a patient lying flat may be missed unless the spine is flat Make it flat by acute flexion of the opposite hip, with the knee bent

Affections of the hip alter the lines of the buttock in the standing position *Affections of the sacro-iliac joint* will produce pain on compression of the anterior superior spines between the examiner's hands

Injury to or inflammation in the region of *the lesser trochanter* of the femur (bursitis, psoas abscess, fracture) results in pain when the seated patient attempts to flex the thigh



Fig 5 Palpating the popliteal space (Bailey Demonstrations of Physical Signs in Clinical Surgery John Wright and Sons Ltd Bristol England)

The inflamed *knee joint* is semi flexed, the depressions on either side of the patella are ballooned out The same is true in hemorrhagic effusion from injury to the semilunar cartilage If either of the lateral ligaments is torn, lateral movement is present The *patella* floats when the joint contains fluid Test for this by ballottement Bear in mind that hip joint affections may be referred to the knee (obturator nerve)

To palpate the *popliteal space* the patient lies on his abdomen and the knee is flexed to a right angle

Metatarsalgia or Morton's toe is detected by compression of the transverse arch, producing pain between the third and fourth toes

MISCELLANEOUS

Fluctuation in a mass is present if the impulse transmitted from the fingers of one hand to the fingers of the other can be elicited in more than one axis

When testing for *translucency* of a mass, use a dark room and allow for normal skin illumination

To detect a minimal degree of *edema,* press on the area with the end of the index finger for ten seconds If pitting is not seen, feel for it by stroking the area with the palm of the hand *Edema produces soft pitting, pus produces induration*

To test for *increased local heat* in an area, use the palm of the hand and rapidly compare it with the corresponding area on the other side, using the same hand

Crepitus over a joint usually means osteo arthritis Crepitus over a tendon sheath indicates *tenosynovitis* with effusion This is most often seen in traumatic tenosynovitis in the snuff box of the thumb (extensor brevis and ossis metacarpi pollicis) Crepitus in the region of a rib fracture not due to the fracture itself signifies laceration of the lung In an area of infection crepitus usually indicates gas bacillus infection

Pulsation in a swelling may be transmitted or intrinsic In the latter case (aneurysm) the impulse is expansile Compression of the main artery proximal to an aneurysm should reduce the size of the aneurysm

Do not probe *fistulas* except in the operating room Exuberant granulations at the mouth of the sinus indicate a foreign body, viz , necrotic bone, nonabsorbable suture, hair (as in a pilonidal sinus)

Cellulitis is distinguished from a localized inflammation by having no sharply demarcated border and by the absence of fluctuation

CHAPTER 2

FLUID AND ELECTROLYTE BALANCE

The surgeon is obliged to deal with acute disturbances in water and electrolyte balance in a wide variety of circumstances It is accordingly necessary for him to understand the physiology of fluid and electrolyte balance and the correct methods of avoiding imbalance or of dealing with it when present

Normal Water Loss

Water is lost from the body by vaporization from the skin and lungs ("insensible" water loss) and as urine The water loss by vaporization assists in the dispersal of body heat and is related to metabolic rate surface area, body temperature, skin circulation, environmental temperature and humidity This water loss proceeds without relation to body water stores In this climate it averages 0 5 gm /kg / hour, or approximately a liter per day in the adult The water of the urine is required for the excretion of end products of metabolism other than carbon dioxide The weight of solid matter dissolved in the twenty four hour urine output of an adult under average conditions is about 35 grams At a specific gravity of 1 029 to 1 032, about 500 cc of water is required to excrete these 35 grams When the urine specific gravity is 1 010 to 1 014, about 1500 cc of water is needed to excrete the same amount of solid Water loss in the urine, therefore is related to metabolic activity, renal function and water stores

A more critical function of the kidneys is the maintenance of constancy in the electrolyte composition of the extracellular fluid, as shown in the table on page 19

Effects of Dehydration

The twenty four hour water loss under ordinary conditions is 2500 cc If the environmental temperature is high or the patient has fever, sweating adds to this loss Loss from sweating may be as much as three liters and in very hot, wet climates as much as ten liters per day

When water deprivation occurs, the demand is first upon the interstitial and vascular depots, which may be considered as one compartment in the following discussion When water shifts, electrolytes must also shift in order to sustain the normal chemical anatomy of the interstitial fluid At first a loss of water is accompanied by a loss of sodium into the urine from the plasma and interstitial fluid When water loss continues, the need for sustaining the sodium concentration in interstitial fluid results in the withdrawal of water from cells

APPROXIMATE ELECTROLYTE COMPOSITION OF BODY FLUIDS
(in milliequivalents* per liter)

	PLASMA		INTERSTITIAL		PANCREATIC		GASTRIC		INTRACELLULAR	
	base	acid	base	acid	base	acid	base	acid	base	acid
Na	142	—	145	—	140	—	20	—	20	—
K	5	—	3	—	5	—	8	—	150	—
Ca	5	—	3	—	—	—	0	—	0	—
Mg	3	—	3	—	—	—	0	—	5	—
HCO_3	—	27	—	28	—	110		0	—	10
Cl	—	103	—	111	—	40	—	145	—	70
HPO_4	—	2	—	x	—	x	—	x	—	50
SO_4	—	1	—	x	—	x	—	x	—	—
Org Ac	—	6	—	x	—	x	—	x	—	—
Prot	—	16	—	x	—	0	—	0	—	35
	155	155								

* This unit describes each ion in terms of its anionic (acid) or cationic (basic) activity and thus facilitates the diagrammatic visualization of the electrolyte structure of the body fluids Conversion from milligrams per 100 cc of any ion to milliequivalents per liter is done by multiplying by 10 and dividing by the equivalent weight (or dividing by the atomic weight and multiplying by the valence) For the phosphate ion the milligrams per 100 cc of phosphorus are multiplied by 1 8 because at the *p*H of normal extracellular fluid 20 per cent of this radical is univalent (H_2PO_4') and 80 per cent is bivalent (HPO_4'') The volumes per 100 cc of CO_2 as carbonic acid or as bicarbonate are converted to milliequivalents per liter by dividing by 2 22 The base equivalence of protein is obtained by multiplying grams of protein per 100 cc by 0 0243

x These values omitted to emphasize variations in sodium chloride and bicarbonate

It is the sodium concentration, therefore, which governs the volume of extracellular fluid The stability of the osmotic value of extracellular fluid is dependent upon renal control of sodium content The kidney undertakes to restore normal sodium concentration by withholding or excreting sodium or water as the circumstances require

Urine formation under normal conditions is understood to proceed according to the following sequence of events The glomerular capillaries filter out some 180 liters of fluid daily The proximal convoluted tubules reabsorb from this filtrate from 60 to 80 per cent of the water, all of the glucose and a fraction of other solutes, including a proportionate amount of sodium chloride A small amount of sodium chloride is reabsorbed in the thin loops of Henle The distal convo

luted tubules reabsorb most of the remaining water and sodium chloride At this point in the process 99 per cent of the water and even more than 99 per cent of the sodium chloride in the glomerular filtrate has been returned to the circulation

Water cannot be reabsorbed as completely as sodium chloride be cause water must be used as a solvent for nonthreshold substances, especially urea Urea, therefore, is the limiting factor for the reabsorption of water

The reabsorption of sodium does not depend upon the amount of water passing through the glomeruli, but on the concentration of sodium in the blood A rise in the concentration of blood sodium stimulates the posterior pituitary lobe to excrete anti diuretic hor mone, which acts upon the convoluted tubules so as to reabsorb more water, thus lowering the blood sodium concentration This is the mechanism by which the need to conserve water in dehydration is met A fall in the concentration of blood sodium stimulates the ad renal cortex to produce steroids which act upon the convoluted tubules to reabsorb more sodium and thus increase its blood concen tration (The loss of cortical function in Addison's disease results in the failure of reabsorption of sodium The water required as a sol vent for the unreabsorbed sodium is the water lost from the ex tracellular spaces in response to the fall in sodium concentration This results in rapid dehydration and shock Parenteral saline solu tion is, therefore beneficial in an Addisonian crisis The effectiveness of desoxycorticosterone an artificial steroid, lies in its ability to cause the renal resorption of sodium, which in turn results in the re absorption of water)

Edema in any condition which lowers the plasma protein concen tration (starvation nephrosis, liver disease) is due to decreased ability to draw extracellular fluid back into the blood stream The edema of cardiac disease is due to increased venous and capillary pressure with transudation into the tissues In both situations there is a resulting fall in plasma volume (The evidence for the alleged primary retention of sodium and a resulting increase in plasma vol ume as the cause of edema in cardiac failure is of doubtful validity) To the kidney a fall in circulating plasma volume represents a need to conserve water, regardless of the amount of fluid in the extracellu lar space The response is, therefore, a reabsorption of more salt and in turn of more water Thus the edema becomes cumulative

Water intake does not aggravate edema because the resulting fall in sodium concentration inhibits anti diuretic hormone and the water is excreted Restricting water intake does not reduce edema sig

nificantly because the resulting rise in sodium concentration elicits the anti diuretic reaction and water is conserved Giving sodium salts obviously makes matters worse, whereas withholding sodium is helpful, because as the sodium level falls the anti diuretic hormone also falls and the excreted sodium takes water with it Serum al bumin is an effective diuretic because the increase in blood volume lowers the sodium concentration, which inhibits the secretion of the anti diuretic hormone

It is because of the fact that the kidney does not adjust immedi ately to sustain ionic equilibrium that the shift in water between extra and intracellular compartments occurs When the kidney takes over, balance is restored If it does not, balance is not restored If de hydration is severe, the kidney is injured and does not take over

Dehydration of the intracellular compartment probably begins when the sodium concentration of the extracellular fluid rises perceptibly above normal In severe dehydration, the water lost by the body is considered to derive equally from the cells and the extra cellular fluid In adults, experimentally dehydrated by water dep rivation, clinical and chemical evidences of severe dehydration are found when the water loss is equivalent to 6 per cent of body weight When this happens, fat, then carbohydrates and finally proteins are catabolized, three grams of water being released for each gram of body protein lost Unrelieved anhydremia or dehydration depresses oxidative processes, with resulting increase in acid metabolites, i e , phosphate and sulfate liberated from glycogen, and ketone acids liberated from fat The reduced volume of blood flow slows renal excretion and causes retention of these metabolites and of nonprotein nitrogen The reduced volume of blood flow also inhibits heat loss from the skin, with resulting fever Salivary secretion stops, the skin becomes dry and flaccid, eyeball tension falls and the facies becomes pinched This is the clinical picture of severe dehydration

In severe dehydration, plasma volume is better sustained than interstitial volume, but the plasma volume falls, nevertheless, and the hematocrit and plasma total protein concentration rise If de hydration is slow, plasma volume is fully protected for a while, but at the expense of the interstitial compartment For some days there is no change in the plasma structure until the time comes when the interstitial space is being maximally depleted Then appear the rapid and alarming signs of failure to sustain plasma volume In other words, shock occurs This explains the relatively symptomless early stage of diarrhea and the rapid collapse in protracted cases, especially in infants

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Water intake does not aggravate edema because the resulting fall in sodium concentration inhibits anti diuretic hormone and the water is excreted Restricting water intake does not reduce edema sig

(6) If hypertonic saline solution is taken, as by men on life rafts at sea, the rise in sodium concentration in the interstitial compartment dehydrates the cells The kidney can excrete salt up to twice isotonic concentration, i e, up to 300 mEq/per liter of urine Since sea water has 450 mEq/per liter, a permanent excess of sodium exists so long as it is the only fluid taken, so that the more sea water taken, the worse the dehydration of the cells Only water can then restore balance

(7) Edema cannot occur without the retention of sodium as well as water In normal individuals with a normal renal capacity, edema can be produced by an intake of an excess of physiologic saline solution, because this fluid passes from blood to tissue spaces before the kidney excretes it

The accumulation of edema fluid is characteristically greatest in the skin and subcutaneous tissue, the lung and at the site of injury or operation The subcutaneous edema is the most obvious and least harmful It will be found, if dependent areas are examined, in the majority of patients receiving more than their total water requirements in the form of saline infusions

Pulmonary edema is a dangerous development It must be particularly feared in the presence of acidosis, uremia, pulmonary alveolar injury or congestive heart failure

Edema at the site of operation is ordinarily transitory Excessive sodium administration increases edema in wounds This may result in retarded healing, necrosis and perhaps failure of an anastomosis with fatal outcome Given time, the edema of excessive saline administration can be eliminated by substituting dextrose for sodium chloride without diminishing total water intake

(8) Another cause of edema is hypoproteinemia, which occurs in malnutrition and in nephrosis The decreased osmotic tension of the plasma allows retention of water and salt in the interstitial spaces Such patients are especially prone to edema from excess saline solution A low salt intake will eventually result in a dilution of interstitial sodium, which the kidney will then excrete along with the edema fluid

(9) In renal disease in which the ammonium ion is not available to excrete chlorides, the chloride is given, not as sodium chloride, but as an acid salt Sodium, therefore, is drawn from the interstitial compartment and with it, water This is one way to treat edema in renal disease

(10) In traumatic shock due to local injury, blood or plasma and interstitial fluid accumulate in the injured tissues The sodium and

Disturbances in Sodium Concentration

A disturbance in the concentration of sodium is produced in many conditions, as follows

(1) When chloride (anion) is lost in excess of sodium (cation), as in pyloric obstruction (see table), the bicarbonate increases to restore anion loss The rise in bicarbonate results in alkalosis Sodium is then excreted to restore acid base balance The excretion of this sodium requires a corresponding excretion of water, with a resulting dehydration in excess of the deficit due to vomiting The dehydration cannot be corrected by giving water alone, because water will not be retained without a corresponding amount of sodium to hold it Accordingly, physiologic saline solution must be supplied to restore the normal ionic and water requirements It is not essential that fluid and electrolytes secreted into the intestine be vomited to produce the deficiency Loss into the gut is a loss to the body Intestinal obstruction, especially of the colon, is not always accompanied by extreme fluid loss When it is, proper fluid and electrolyte therapy are essential

(2) In pancreatic fistula, sodium is lost in excess of chloride Water is therefore also lost A state of dehydration, in excess of that due to water lost via the fistula, and acidosis result

(3) Acidosis also occurs in diarrhea Whole gastro intestinal juice is equivalent to a plasma filtrate and its loss at first does not impair osmotic balance But the dehydration, if uncorrected, causes a loss through the kidney of sodium in excess of chloride Accompanying starvation produces acid metabolites which the injured kidney can not excrete Hence, whether the fluid lost from the gut is a balanced or unbalanced fluid does not matter so far as the eventual result is concerned Acidosis as well as dehydration will be present if the diarrhea is protracted

(4) The ingestion of acid producing salts depletes the base re quired for the excretion of acid radicals Water is therefore lost along with the base This is how diuresis is induced by acid producing salts administered for the treatment of edema

(5) Excessive sweating as in patients under anesthesia and covered with blankets in hot weather, causes loss of salt as well as water If the deficiency becomes extreme, the tissues lose water and dullness, nausea, muscle cramps and exhaustion result One half per cent sodium chloride solution orally rapidly relieves the patient

Similar symptoms are produced in acute Addison's disease, which causes a loss of sodium because of defective renal tubular absorption Rapid dehydration occurs Salt solution relieves the acute collapse

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water content of the extravasated fluid is often high, the sodium exceeding its normal ratio to water The sodium and water are drawn from the interstitial spaces Intracellular fluid is also lost in consequence The interstitial spaces show a loss of sodium and a gain in potassium If the dehydration is significant, as can be determined by a rise in hematocrit and total protein concentration of the blood, sodium and water should be provided in addition to the blood or plasma requirement Dehydration in simple hemorrhagic shock is usually slight

(11) In severe burns the loss of fluid is great, but the plasma deficiency needs correction more urgently than that of water and salt As expected, plasma and saline solution are definitely superior to plasma alone (See section on Burns)

Dehydration is due to (1) a *primary loss of water* (e g , in fasting or vomiting) or (2) *primary loss of sodium* (e g , Addison's disease) While a primary deficiency of either eventually leads to a loss of the other, the unequal losses of water and sodium cannot be adjusted immediately Hence the effects of these two causes of acute dehydration are not exactly the same Both types deplete the volume of fluid in the interstitial space equally, but the effect of acute water loss upon the plasma and hemodynamics is not the same as that of acute sodium loss Cardiac output and plasma volume fall in both The blood total protein is also said to fall in salt loss, but not in water loss * The hematocrit in salt loss increases far more than in water loss The effects of salt loss are more severe than those of water loss because plasma volume falls more in proportion to the loss of extracellular volume Further, salt loss causes overhydration of cells, water loss does not The result of all these changes is that, within certain limits, acute salt loss produces lethargy and shock, while acute water loss does not

Acute salt loss cannot be relieved by water or glucose in water It can be relieved by replacement of salt and water or by plasma (or gelatin) plus some of the salt and water deficit

Whether the dehydration is due to primary deficiency of salt or water can be quickly determined by measuring the urine chloride output The volume of urine times its chloride concentration, which is readily determined by the colorimetric method of Fantus, gives the total chloride output Replacement therapy is guided as follows If chloride replacement is deficient, there is a decline in urinary output of chloride and this is evident sooner than it can be measured by plasma chloride determinations If chloride has been restored to

* Elkinton J F Danowski T S Winkler A W Journal Clinical Investigation *25* 120 1946

normal, the urinary output of chloride will increase even before the plasma chloride level is back to normal

Fasting

Partial or complete starvation is a common experience in very sick people Fasting causes protein breakdown, whether water is taken or not Potassium and magnesium are liberated from tissue protein The release of phosphate and sulfate together with the ketone acids from the incomplete combustion of fats results in acidosis, which increases the excretion of calcium The losses of potassium, magnesium and calcium are replenished from body stores and do not need to be supplied immediately, but eventually replacement by oral feeding will be necessary In fasting salt is also excreted, but in greatly reduced amount because extracellular fluid volume falls in proportion to the fall in total protoplasmic mass The defense of chloride loss is achieved by substituting the bicarbonate ion The defense of the sodium loss is achieved by substituting the ammonium ion synthesized by the kidney and the excretion of monobasic instead of dibasic phosphate But these base sparing mechanisms are very limited and sodium must therefore be supplied

Acidosis and Alkalosis

Acidosis results from dehydration, starvation, loss of sodium in excess of loss of chloride and in other conditions, such as diabetes

Diabetic acidosis is especially dangerous because the excreted glucose takes water with it and therefore more sodium Hence the dehydration and acidosis are progressive The relative starvation also produces ketosis, which causes a further loss of sodium Since the acid metabolites cannot be excreted, the bicarbonate falls and hyperpnea increases If the acidosis is severe, the adjustments necessary occur too slowly because the renal regulating capacity at best is not immediate and in dehydration the kidney is so severely injured that it cannot adjust the chloride balance A greater amount of base is needed This cannot be supplied by adding salt since relatively more cation than anion is required to restore acid base equilibrium This is achieved by a saline sodium lactate solution (see Therapy, p 26) The resulting relative increase in base increases the bicarbonate also and a return toward a normal *p*H is effected

The carbon dioxide content of the blood is a reliable guide to the degree of acidosis when the acidosis is due to a metabolic disorder, which is the usual cause of a lowered carbon dioxide content Rarely, however, a lowered carbon dioxide content develops because it is

water content of the extravasated fluid is often high, the sodium exceeding its normal ratio to water The sodium and water are drawn from the interstitial spaces Intracellular fluid is also lost in consequence The interstitial spaces show a loss of sodium and a gain in potassium If the dehydration is significant, as can be determined by a rise in hematocrit and total protein concentration of the blood, sodium and water should be provided in addition to the blood or plasma requirement Dehydration in simple hemorrhagic shock is usually slight

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enough more to replace the accumulated and current deficit The normal water loss in an adult is 2500 cc daily, but the requirements may be much greater (1) in fever, which increases insensible water loss, and (2) in polyuria due to renal damage in which an obligatory renal water loss arises from the loss of the normal concentrating power

Since the daily need of normal infants and adults is 125 cc and 700 cc of physiologic saline, respectively, the rest of the fluid requirement is provided in the form of glucose in water Giving more salt may be harmful, since it must be excreted and if the excretion is not rapid enough, retention edema and a relative oliguria will occur This type of edema, due to overtreatment with saline solution, is common and may be falsely interpreted as being caused by circulatory failure or renal insufficiency If such patients happen to be receiving sulfonamides, the oliguria may be falsely interpreted as due to drug injury to the kidney, resulting in unnecessary discontinuance of the drug when all that is needed to restore normal volume output is a reduction in salt intake Failure to do so may result in pulmonary edema, defective function of intestinal anastomoses or deficient wound healing

The glucose given also provides calories and spares protein The daily glucose requirement is 14 gm /kg in infants and 6 to 8 gm /kg in adults If there is edema and defective renal function, the glucose given intravenously must be in 10 per cent concentration in infants or 15 per cent in adults in order to meet the caloric requirements without using too much fluid Clyses cannot achieve this objective

The protein requirement can be partly met by whole blood infusions, if there is anemia, or by plasma if there is no anemia or if the hematocrit is too high Pure amino acids are superior to hydrolyzed proteins, but they are not yet available Enzymatic hydrolysates now in use are superior to acid hydrolysates for maintaining nitrogen equilibrium, but given too rapidly they produce reactions and are to a large extent lost in the urine If used with glucose, their concentration must not exceed 3 5 per cent The normal minimal amount of amino acid needed when the glucose intake is adequate is 40 grams daily This may have to be much more, if protein catabolism is or has been excessive (See chapter on Nutrition in Surgical Patients)

In adults, therefore, the minimal fluid and calorie requirements are satisfied by 2600 cc of fluid per day, containing 6 to 7 grams of salt, 40 grams of amino acid and 400 grams of glucose given at a rate of 5 cc per minute in two periods of four or five hours each, such as

blown off faster than the base falls (e g hysterical hyperpnea) In this case there is alkalosis with a lowered amount of carbon dioxide The reverse can also happen i e , an elevated carbon dioxide content due to insufficient blowing off before enough base is gathered to balance it (emphysema) Hence the only certain way to determine whether an altered carbon dioxide content is due to a metabolic or respiratory disorder is to do a blood test for *p*H, which is more reliable than the actual bicarbonate carbonic acid ratio, because the latter is a variable and flexible adjustment, while the *p*H is an exact index of the electrolyte balance

The clinical state will usually help to decide the cause of the imbalance Thus, loss of gastric juice produces an alkalosis There is enough sodium in gastric mucus to produce a sodium deficiency also, up to one half the chloride loss This will produce dehydration in the presence of an alkalosis In treating dehydration due to vomiting by saline solution, the sodium deficiency is made up sooner than the chloride deficiency, so that sodium in excess is excreted as sodium bicarbonate while chloride is retained Thus the urine will have an alkaline *p*H, but when balance is restored, the urine *p*H should be acid In diarrhea the loss is from the whole gastro intestinal tract and, if it continues, dehydration acidosis develops

THERAPY

In general, it may be stated that though ideal therapy in deficiency states calls for a fluid with the structure of extracellular fluid, all necessary constituents except sodium and chloride can be derived from the tissues Hence nothing more than saline solution is needed to restore water and electrolyte balance, *providing renal function is normal* Since dehydration injures renal function, water in addition to that needed for the sodium chloride must be supplied to restore the kidney This water is provided by adding glucose in water to saline solution The glucose solution acts as a diuretic and as a food which destroys ketone acids

When the distortion in acid base balance is severe, one cannot wait for the resumption of renal function to correct it Therefore, if acidosis is present, sodium lactate is given with the glucose and saline solution If there is alkalosis, salt and glucose solution are sufficient to restore balance

Parenteral Fluid Therapy

If the patient cannot take anything by mouth, parenteral therapy must provide, in addition to the normal daily requirements,

enough more to replace the accumulated and current deficit The normal water loss in an adult is 2500 cc daily, but the requirements may be much greater (1) in fever, which increases insensible water loss, and (2) in polyuria due to renal damage in which an obligatory renal water loss arises from the loss of the normal concentrating power

Since the daily need of normal infants and adults is 125 cc and 700 cc of physiologic saline, respectively, the rest of the fluid requirement is provided in the form of glucose in water Giving more salt may be harmful, since it must be excreted and if the excretion is not rapid enough, retention edema and a relative oliguria will occur This type of edema, due to overtreatment with saline solution, is common and may be falsely interpreted as being caused by circulatory failure or renal insufficiency If such patients happen to be receiving sulfonamides, the oliguria may be falsely interpreted as due to drug injury to the kidney, resulting in unnecessary discontinuance of the drug when all that is needed to restore normal volume output is a reduction in salt intake Failure to do so may result in pulmonary edema, defective function of intestinal anastomoses or deficient wound healing

The glucose given also provides calories and spares protein The daily glucose requirement is 14 gm /kg in infants and 6 to 8 gm /kg in adults If there is edema and defective renal function, the glucose given intravenously must be in 10 per cent concentration in infants or 15 per cent in adults in order to meet the caloric requirements without using too much fluid Clyses cannot achieve this objective

The protein requirement can be partly met by whole blood infusions, if there is anemia, or by plasma if there is no anemia or if the hematocrit is too high Pure amino acids are superior to hydrolyzed proteins, but they are not yet available Enzymatic hydrolysates now in use are superior to acid hydrolysates for maintaining nitrogen equilibrium, but given too rapidly they produce reactions and are to a large extent lost in the urine If used with glucose, their concentration must not exceed 3 5 per cent The normal minimal amount of amino acid needed when the glucose intake is adequate is 40 grams daily This may have to be much more, if protein catabolism is or has been excessive (See chapter on Nutrition in Surgical Patients)

In adults, therefore, the minimal fluid and calorie requirements are satisfied by 2600 cc of fluid per day, containing 6 to 7 grams of salt, 40 grams of amino acid and 400 grams of glucose given at a rate of 5 cc per minute in two periods of four or five hours each, such as

from 8 A M to 12 noon and 4 P M to 9 P M If better retention and utilization of the calories and fluid is desired, somewhat more salt should be added

In infants the minimal fluid and calorie requirements are met by 700 cc of fluid containing 70 grams of glucose, 1 gram of salt and 12 grams of amino acid given at a rate of 13 drops per minute for seventeen hours

Given this way, at the rate suggested, the glucose may exceed somewhat the oxidative utilization of glucose and permit some glycogen storage, without producing hyperglycemia, edema or cardiac overloading More rapid rates might produce glycosuria or even a diuretic effect of some consequence The nutritional state, fever and infection influence these factors in as yet not precisely defined ways

The foregoing are maintenance requirements which must be considered minimal and to which more must be added in case of starvation or dehydration

Although the state of dehydration is in general reflected in determinations of body weight, hemoglobin, plasma protein and nonprotein nitrogen values, clinical observation, particularly a detailed history and physical examination, will prove to be a more practical guide to the needs of the patient than such laboratory determinations Thus a history of weight loss, starvation, vomiting, diarrhea, sweating and similar disorders will indicate the type and extent of the fluid loss, the degree of starvation and whether acidosis or alkalosis are likely accompaniments Clinical appraisal of weight loss, the tongue, turgor of skin, eyeball tension, urine volume and concentration tell much regarding hydration Carpopedal spasm or a positive Chvostek sign suggests alkalosis, deep respirations suggest metabolic acidosis, and shallow and irregular respirations suggest alkalosis Urinary *p*H is not always a safe index of alkalosis or acidosis e g , it is not unlikely, in alkalosis from pyloric obstruction, to find an acid urine because of the low sodium in plasma A detailed fluid intake and output chart and nurses' notes are indispensable One cannot rely on a laboratory figure to the exclusion of clinical judgment In general, the water requirements of the patient are satisfied when the daily urine output equals or exceeds 1200 to 1500 cc in an adult

Practical Hints in Therapy The normal sodium concentration in interstitial fluid and plasma is 145 mEq/liter and of chloride 103 mEq/liter Physiologic saline contains 145 mEq/liter of each

If there is dehydration and alkalosis because of loss of chloride in excess of sodium, physiologic saline is appropriate to provide the chloride deficiency without increasing the sodium, because the ex

cess sodium is excreted as sodium bicarbonate Glucose in 10 per cent solution is added to relieve starvation ketosis if the amount of fluid needed is relatively small, in 5 per cent solution if large amounts of fluid are needed

If there is dehydration and acidosis (low carbon dioxide), as in diarrhea, physiologic saline is undesirable, since the acid anions (chloride and ketone) are already too high and the bicarbonate too low In this situation physiologic saline would keep bicarbonate low and hyperpnea would continue Therefore one should use glucose solution to act as a diuretic and so get rid of the excess chloride and ketones But if renal function has not been restored, the acidosis will not be corrected without the use of sodium bicarbonate or sodium lactate The correct proportions of acidic and basic anions in this situation are provided by a solution of two parts 0 85 per cent salt and one part m/7 sodium lactate (144/mEq/liter sodium and 97 mEq/liter chloride) The volume of fluid to be used equals the normal basal daily requirement plus the existing deficiency, which is 6 per cent of body weight in severe dehydration If the exact amount of loss of fluid is not known, give the fluid until hyperpnea is corrected (which is a correct guide, except in shock) Add plasma if serum protein is low or whole blood if hemoglobin and serum protein are low As soon as renal function is restored, omit the sodium lactate

To repair intracellular loss, add protein hydrolysates Begin oral feeding as soon as possible

If proper fluid therapy has been given for twenty four hours and a close appraisal of further needs is required, one may with less than 5 cc of blood then determine and be guided by the values for hemoglobin, serum protein, nonprotein nitrogen, salt, carbon dioxide and *p*H

Postoperative Fluid and Electrolyte Therapy

Most patients do not require sodium chloride unless a deficit occurring during or after operation requires correction Temporary renal suppression will decrease the normal loss of sodium chloride and even less than the daily requirement is usually needed During the first two postoperative days glucose and water without sodium chloride will be adequate in most cases If a small deficit exists, a liter of 0 5 per cent saline solution per twenty four hours may be sufficient

If water loss during and after operation is minimal and the patient can retain fluids orally on the same day intravenous therapy may be omitted altogether Routine administration of intravenous fluids postoperatively is unnecessary

CHAPTER 3

NUTRITION IN SURGICAL PATIENTS

Patients with a chronic illness remediable by surgery often harbor marginal states of nutritional imbalance, which mav not be clinically apparent until the nutritional losses incident to the operation and the postoperative period precipitate an obvious state of dietary deficiency Not infrequently major malnutrition is the most challenging preoperative problem It may influence the choice of surgical procedure or contraindicate surgical therapy It is essential to recognize and deal with nutritional deficiency before structurally irreversible damage occurs, especially in patients with liver disease, gastro intestinal disorders and hyperthyroidism Deficiencies develop because of (1) deliberately inadequate intake due to food fads, economic considerations, restrictive diets (2) inadequate intake resulting from anorexia, (3) inadequate absorption attributable to diffuse or localized gastro intestinal disturbances, (4) increased requirements due to increased catabolism, as in fever, hyperthyroidism, sepsis, burns, major trauma or neoplasm, (5) increased rate of loss as in vomiting, diarrhea, intestinal fistula, inflammatory exudates and (6) defective utilization, as in diseases of the liver

A detailed history of the dietary intake may be more important than physical signs for detecting subclinical malnutrition, in view of the broad zone existing between optimal nutrition and frank clinical deficiency Such a dietary history should include specific information as to the daily intake of important essential food factors, such as meat, fish, vegetables, fruits and dairv products Svmptoms suggestive of impaired nutrition include fatigue, weight loss, sore tongue, sialorrhea, bleeding gums, dyspnea, paresthesias and night blindness

Physical signs may be entirely absent More obvious manifestations of deficiency include loose skin, peripheral edema, hyperkeratotic papules around hair follicles, petechial hemorrhages, fatty desquamation around the alae nasi, fissures at the corners of the mouth and outer angle of the eyes red, smooth tongue and polyneuritis

It is insufficient in the management of malnourished patients merely to restore their water and electrolyte balance or to adjust the peripheral blood count value by transfusions It is important to realize that synthetic preparations administered either orally or parenterally cannot replace a well balanced diet, especially in individuals whose preoperative course has been conditioned by an inadequate diet or by malabsorption over a long period of time Many synthetic preparations do not contain all the required nutrients or do so in proportions which are not optimal

Proper attention to the individual's requirements may obviate those complications of surgery which often are the direct result of dietary inadequacy, such as impaired wound healing, delayed intestinal motility, anastomotic stomal difficulties, anemia, reduced antibody formation and postoperative infections

PROTEIN NUTRITION

The most difficult and the most critical aspect of the nutritional problem in surgery is that of maintaining or restoring protein nutrition The average normal daily urinary nitrogen loss of a healthy adult is 13 5 grams of nitrogen (equivalent to 84 grams of protein) The loss during starvation is less After injury, including surgery, this loss may rise to 20 to 40 grams per day (125 to 250 grams of protein) exclusive of the loss of blood or plasma As much as 10 grams per day (63 grams of protein) may be lost in exudates When tissue protein is lost, four times as much tissue water is lost with it, so that a twenty four hour urinary nitrogen excretion of 20 grams is equivalent to a loss of 625 grams or 1 5 pounds of tissue

The weight loss incident to acute starvation is almost all due to water loss If dehydration is prevented, the weight loss represents tissue loss The average daily weight loss in the immediate postoperative period will vary from 1 to 3 pounds with an average total postoperative loss of 8 pounds The true loss may be masked by overhydration, usually resulting from excessive intravenous saline therapy The normal total plasma protein ranges from 6 to 8 grams per 100 cc (albumin 4 0 to 5 5 and globulin 1 5 to 3 0 gm per 100 cc) Since the albumin may fall and the globulin rise as in infection, the total serum protein value even if normal, may be misleading Many postoperative patients show a fall of 0 5 grams per 100 cc of serum albumin, which is equivalent to a loss of 510 grams of body protein

The symptoms and signs of protein deficiency are lassitude, weakness, anorexia and digestive disturbances In advanced cases, nu

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intravenously may not be properly utilized if the amino acids contained in the particular protein fed become available in unsuitable sequences or proportions Hence, the oral alimentation of natural proteins is always preferable, whenever possible

When *feeding* must be done *via a jejunostomy*, there is likely to be difficulty from distention, cramps and diarrhea, due partly to the sudden influx of a large volume of fluid Frequently there is failure of absorption The feeding should be done by continuous drip, not exceeding 200 cc per hour, or by giving 100 cc in a period of fifteen minutes every hour A cautiously graded increase up to 200 to 300 cc per hour will eventually be tolerated after some days

If a continuous drip is given, an ordinary sterile intravenous set should be used so that the incoming stream of air bubbles will help to keep the mixture from settling The mixture must be sufficiently fluid so that the dispensing apparatus is not clogged and yet not so dilute that the volume will be excessive

The formula to be described meets these requirements A daily intake of some 2400 cc of this formula will provide the average daily calorie and water requirement Additional water and electrolyte may be given by vein, whenever required The fluid is non irritating and has a *p*H between 6 5 and 7 5 It is not excessively hypertonic It contains easily digested and predigested substances because the food will not be exposed to salivary or gastric secretion and also because pancreatic action probably will be limited

The formula is as follows

Water		760 cc
Amigen essenamine parenamine		85 gm or more
Dexin (dextrins and maltose)		150 gm
Thin cream (18 5%)		85 cc
Salt mixture		10 gm
(proportions of salt mixture)		
NaCl	100 gm	
KCl	100 gm	
$MgSO_4$	46 gm	
Ca gluconate	100 gm	
NaH_2PO_4 dried	160 gm	
Vitamins (minimum amounts)		
Halibut liver oil	0 33 cc	
B complex (Nutriplex)	2 0 cc	
Ascorbic acid	63 0 mg	

The mixture is made up as follows the amino acid, carbohydrate and the salt mixture are dissolved in warm tap water, without stirring, to a volume of about 900 cc This is transferred to a milk bottle, capped and sterilized After cooling to below 5° C , the vitamins are added, the ascorbic acid being first dissolved in a small amount of

tritional edema, deficient wound healing and bed sores may develop

The minimum daily requirement of protein in health is 0 6 gm per kg of body weight One gram per kilogram, therefore, is a proper but by no means optimal allowance in the average case This is be cause more than a gram of protein is required to replace a gram of protein lost A high protein diet should contain 130 gm of protein per day, but it is one thing to prescribe it and another to see that it is ingested, since a high protein diet has large bulk and high satiety value

When it is vital that the patient take the diet in full, special nurs ing will be of great value The attractiveness and palatability of food will be better and the patient's preferences are more likely to be met and his cooperation more likely to be secured

The average patient will not take this amount of protein as or dinary food and will require supplements Parenteral supplements such as intravenous amino acids frequently defeat their purpose be cause they reduce the patient's appetite *Oral supplements,* how ever, in the form of protein rich food concentrates which are not predigested, will help to bring the intake to the desired level These are dried whole milk (25 per cent protein), dried skim milk (33 per cent protein), soybean flour (37 to 45 per cent protein), dried yeast (45 per cent protein) or peanut flour (50 to 60 per cent protein) These may be given in any form suitable to the patient

Defatted dried skim milk is the basis of several commercially available high protein supplements for oral feeding It may be added to liquid whole milk in the approximate proportion of 10 gm dried skim milk per 100 cc whole milk (vanilla or chocolate may be added for flavor) thus 2 tablespoonsful of dried skim milk to an 8 ounce glass of whole milk yields 15 grams of protein per glass This may be added to other liquid vehicles such as tomato soup

The following mixture is a suitable preparation 5 gm salt, 6 whole eggs, 2 egg whites, 120 gm of skim milk powder, 200 gm of lactose, skim milk q s 1000 cc This provides 2500 calories in the form of 400 grams of carbohydrate, 120 grams of protein and 35 grams of fat

Partially or completely hydrolyzed proteins are available, but they are not necessary for oral feeding unless there is poor digestion or absorption, in which case they may be superior to the foregoing supplements which are not predigested

In spite of the fact that nitrogen equilibrium can be achieved by supplying protein in the form of a hydrolysate, there is uncertainty as to its nutritional value Predigested proteins whether fed orally or

intravenously may not be properly utilized if the amino acids contained in the particular protein fed become available in unsuitable sequences or proportions Hence, the oral alimentation of natural proteins is always preferable, whenever possible

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(proportions of salt mixture)		
NaCl	100 gm	
KCl	100 gm	
$MgSO_4$	46 gm	
Ca gluconate	100 gm	
NaH_2PO_4 dried	160 gm	
Vitamins (minimum amounts)		
Halibut liver oil	0 33 cc	
B complex (Nutriplex)	2 0 cc	
Ascorbic acid	63 0 mg	

The mixture is made up as follows the amino acid, carbohydrate and the salt mixture are dissolved in warm tap water, without stirring, to a volume of about 900 cc This is transferred to a milk bottle, capped and sterilized After cooling to below 5° C , the vitamins are added, the ascorbic acid being first dissolved in a small amount of

sterile water The solution is kept in the refrigerator until required for use, when it is warmed to body temperature and the cream added with vigorous shaking

If feeding must be entirely *parenteral,* the problem is difficult The proteins available are varied, but they all have disadvantages Human plasma, whole blood, plasma albumin and globin are not available in sufficient quantity to provide the entire protein requirement Bovine albumin has not been proved safe Gelatin is readily available, but it requires fortification with essential amino acids to make it nutritionally adequate

Solutions of amino acids (e g , lyophilized amino acids, "parenamine," "amigen") prepared by acid or enzymatic hydrolysis of casein (or other proteins) are available commercially *

The hydrolysates are not antigenic and are utilized in protein anabolism The high incidence of reactions—e g , nausea, vomiting, flushing, headache—which accompany their intravenous administration limits the desirable concentration to not over 5 per cent and the time needed for administration to not less than two hours for each liter Glutamic acid and aspartic acid to a lesser extent—both nonessential amino acids—are present in relatively large quantities in casein hydrolysates and are apparently responsible in large measure for nausea and vomiting If protein in the form of most commercially available hydrolysates is given so as to provide 0 6 gm /kg of body weight, the salt content is likely to be excessive

Improvement in the manner of preparation of amino acid solutions may be expected to increase their usefulness A lyophilized casein hydrolysate, free of sodium chloride, glutamic and aspartic acids, which can be given in 10 per cent solution without reactions, is now available Solutions of pure crystalline amino acids have been shown to be capable of providing adequate protein nutrition without adverse side effects, but they are still too expensive for clinical use

CALORIC REQUIREMENTS

Unless the total caloric need is being met, intravenous amino acids will be utilized for calories and thus wasted as far as protein synthesis is concerned The fat content of the normal diet provides 20 to 40 per cent of the total calories Since fat as yet cannot be fed intravenously, glucose is the major source of calories for a patient who must be fed wholly intravenously Since 400 grams of glucose

* In prescribing a particular brand of protein hydrolysate for intravenous use note should be taken not only of the total amino nitrogen but of the amount present in the form of free amino acids There is wide discrepancy among the different preparations

must be provided and since the total fluid volume should not greatly exceed 2500 to 3000 cc per day, this amount of glucose is added to 2500 cc of a 5 per cent solution of amino acid The resulting 15 per cent glucose concentration may induce venous thrombosis This is unavoidable To administer this amount of glucose in 2500 cc volume requires not less than nine hours if loss of glucose in the urine is to be avoided and full utilization obtained This is best achieved by venoclysis in two periods of four and one half hours each Sufficient protein, carbohydrate and calories are thus made available for average daily requirements Any caloric deficiency will then be met from the patient's own store of body fat

The intravenous administration of finely emulsified fat, when available, would offer an alternative way of providing calories without the need of intravenous therapy so prolonged as to immobilize the patient in bed for long periods *

Omission of fat, however, is not a crucial deficiency for short range illnesses, since the disease states attributable to lack of specific fatty acids occur only after prolonged fat deprivation and in any case have been demonstrated only in animals, not yet in man But the fat-soluble vitamins, A, D, E and K, should be given with the water soluble vitamins parenterally when oral feeding is impossible or is defective because of inadequate absorption of fat, as in fever, steatorrhea, chronic diarrhea, intestinal obstruction, obstructive jaundice or total biliary or pancreatic fistula

Fat is necessary for the absorption of carotene and vitamin A and bile is necessary for the absorption of vitamins D, E and K When fat can be taken by mouth and bile is present in the gut, it is not necessary to give vitamins A, D, E or K because fat contains enough of them If bile is not present, bile acids must be given or the vitamins must be administered parenterally, except for the water soluble vitamin K which can be absorbed from the gut without the aid of bile salts Bile salts are not necessary, but help the absorption of vitamin A Mineral oil inhibits the absorption of carotene, but not of Vitamins A, D, E or K

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* A homogenized emulsion of cocoanut oil and serum albumin offers some promise of being a useful means of supplying fat parenterally Another possible source of fat at present under investigation is a complete intravenous meal with the following formula

1 liter 6 per cent infusion gelatin (as stabilizer)
1 liter 5 per cent hydrolysate of protein
200 cc 5 per cent glucose
100 grams pure refined edible cocoanut oil

This mixture is emulsified homogenized and stored under refrigeration Before use Vitamin B_1 and methionine are added to insure proper utilization of the fat

The water soluble vitamins B and C are poorly absorbed when there is gastro intestinal disease with defective absorption or when absorption is inhibited by adsorbent drugs such as kaolin or aluminum hydroxide

VITAMINS AND MINERALS

The daily vitamin requirement in parenteral feeding has been varyingly estimated as follows

	Minimal Requirement	Sick Surgical Patient
Thiamine	2 mg	20–40 mg
Nicotinic acid	20 mg	150–300 mg
Riboflavin	3 mg	20–40 mg
Ascorbic acid	75 mg	500–1000 mg
Vitamin A	5000 units	15 000 units
Vitamin D	1000 units	1 500 units
Vitamin K	3 mg	3 mg

The B complex is especially necessary when a patient is being fed parenterally, because combustion of carbohydrate greatly increases the requirement of B complex above what is required during starvation

A lack of vitamin D interferes not only with bone metabolism but with *absorption of calcium* from the gut Deficient absorption of calcium may also result from achlorhydria or alkali therapy, because its absorption, which occurs in the duodenum, is best achieved at an acid *p*H Excessive ingestion of oxalic acid (in leafy greens), phytic acid (in cereals), phosphorus, magnesium or potassium interferes with calcium absorption because they precipitate it as an insoluble, non ionized salt Too much fat forms insoluble calcium soaps

Iron interferes with the absorption of phosphorus The absorption of iron is diminished by achlorhydria, diarrhea and inflammation anywhere in the body

Thiamine is destroyed by anti acids or in achlorhydria It is inactivated by raw clams, raw meat and raw fish containing a thiaminase Ascorbic acid can be inactivated by certain intestinal organisms and biotin by raw egg white

Thus not only deficient dietary intake, but defective absorption may result in malnutrition The latter may also result from a deficiency of conveyance by an essential carrier or by a deficient mechanism of acceptance Ascorbic acid is stored in the adrenals vitamin E in heart muscle, vitamin A in the liver riboflavin in the liver and

kidney Disease of these organs may interfere with acceptance Conversion for utilization may be deficient Carotene must be converted to vitamin A, thiamine to cocarboxylase, riboflavin to flavoprotein, and nicotinic acid to coenzymes I and II These conversions, largely done by the liver, may fail in cirrhosis or other hepatic injury, e g , in alcoholism, obstructive jaundice, thyrotoxicosis or myxedema Radiation sickness interferes with coenzyme synthesis from thiamine or nicotinic acid The utilization of vitamins is interfered with in protein deficiency and by antivitamins Polyuria and lactation may cause excessive loss of water soluble vitamins Loss of ascorbic acid by excretion is increased by salicylates, barbiturates, anesthetics, estrogens and sulfonamides

Stress imposed by exertion, fever, drugs and toxins may increase tissue requirements for a given nutrient or deplete the tissues of an essential nutrient For instance, in fever the need for ascorbic acid is increased because any increase in basal metabolism raises the need for it Exercise increases the need for the B vitamin (utilization of carbohydrate) Methionine is especially needed for detoxification by the liver Chloroform, carbon tetrachloride and other liver toxins induce a methionine deficiency

A negative nitrogen balance develops from the loss of amino acids which are freed from proteins catabolized for the purpose of obtaining others required for detoxification functions Thus, methionine is utilized in burns, ascorbic acid, riboflavin, pyridoxine and para aminobenzoic acid are consumed in poisonings of various types, including bacterial toxins, and in hyperthyroidism In these circumstances, the development of protein deficiency is not readily prevented, nor is the deficiency easily remedied even by a large intake of proteins because the requirements for protein in such situations may become many times normal

Hypoproteinemia occurs in a variety of conditions, particularly in nephrosis, liver disease and prolonged malnutrition Such patients are not only slow to heal wounds, but are more susceptible to infection, drugs and traumatic experiences in general The accompanying edema interferes with tissue function as well as wound repair witness the edema at the site of a gastro intestinal anastomosis, which interferes with emptying, and the lack of tonicity in the gastro intestinal musculature Even if patients can take food in adequate quantity, the correction of this deficiency is rather slow Improvement may not occur in spite of adequate food intake if the underlying cause (renal disease, cirrhosis of the liver, sprue, and the like) is not eradicated When food intake is insufficient, human

plasma,* globin or albumin, given daily and in large amounts will assist in restoring a normal state These substances are not retained for long in the circulation, but must, like other proteins, be stored, catabolized and resynthesized

The problem of getting patients to take a proper diet when malnourishment complicates the presenting disorder is an inescapable responsibility of the surgeon The patient's appetite is not a reliable criterion of his needs He must be continuously impressed with the importance of his diet in relation to his physical status If the patient cannot or will not cooperate, it remains the surgeon's job to change or supplement what is offered by mouth until the nutritional need is met

* The danger of virus hepatitis from human plasma or its derivatives is real The donor source should be limited to pools not exceeding three plasmas

CHAPTER 4

HEMORRHAGE AND TRAUMATIC SHOCK

This condition is a state of collapse of the peripheral circulation clinically recognizable by the presence of one or more of the following signs (1) cold, pale and clammy skin, including the forehead, (2) collapsed veins, (3) a rising pulse rate, (4) pallor and slight cyanosis of mucous membranes, which will show prolonged blanching on pressure, (5) restlessness, (6) usually, but not always, a falling blood pressure, (7) anorexia with or without nausea, (8) decreasing or absent urine output

PRINCIPLES OF THERAPY

Shock should be anticipated in blood loss, major fracture, extensive soft tissue injury, deep or extensive burn, intracranial injury, intestinal obstruction, extensive surgical procedures, perforation of a viscus, acute pancreatitis and in severe acute sepsis Therapy should be given to avert impending shock as well as to treat the overt state of shock Anesthesia and surgery should be avoided, if possible, until shock is corrected, except in a case of active hemorrhage

A loss of plasma, as in burns or intestinal obstruction, or a loss of whole blood, as in hemorrhage, is the usual cause Since 30 to 40 per cent of the blood volume may be lost before the full blown condition is present, the amount of blood which must be given to restore the normal blood volume is a minimum of 1500 to 2000 cc in an otherwise normal adult The cardiac output is so low that a small additional loss of plasma or blood during shock may cause death Since the capillary flow is deficient in both volume and velocity, progressive tissue deterioration occurs with time, leading to irreversible changes This is why early treatment is essential and effective and why late treatment, regardless of how much fluid is given, may not be effective

Shock can be due to severe infection The infection can occasionally create a large loss of plasma and extracellular fluid, but there may be no significant loss of blood volume It is then useless to attempt cure of the shock state by volume replacement therapy alone Specific chemotherapy, when available, is necessary and more important

Transfusions

In the therapy of shock due to blood volume deficiency, the material to be transfused depends on what is lost (1) In the early state

of extensive burns plasma and extracellular fluid are lost in large amounts These must be supplied at once Because anemia develops rapidly, whole blood will be needed within twenty four hours to replace red cell as well as plasma loss or to anticipate red cell loss Only when the hematocrit (i e , blood viscosity) is very high will plasma alone be preferable, since the high viscosity reduces the already lowered cardiac output Even then, whole blood is used if plasma is not available, since the most important need by far is that of volume replacement (2) For hemorrhage whole blood is necessary, of course Plasma is not used unless blood is not available If neither blood nor plasma is available a 6 to 8 per cent solution of sterile gelatin is satisfactory, but not if more than 1500 cc is needed Gelatin may produce a transient renal injury Glucose and salt solution are not to be relied upon for replacement of blood volume deficiency They are often needed as supplements to replace extracellular fluid loss, if this exists at the same time, as in burns (3) In shock due primarily to dehydration, as in diabetic coma, saline solution with added glucose is essential If there is acidosis, add sodium lactate (see Fluid and Electrolyte Therapy) In severe dehydration there is some plasma loss, so that plasma or whole blood may also be given

If shock is due to blood volume loss, the signs which indicate that the blood or plasma which has been given is enough are a warm dry skin, return of normal color, normal blood pressure, a slowing pulse rate and return of a normal urine output

One seldom errs on the side of too much blood or plasma, but too much saline solution can cause pulmonary edema If diuresis does not occur in response to adequate fluid administration, forcing more fluid is not only useless, since the kidney will not respond, but severe harm will result from pulmonary edema If anuria or oliguria persists after volume deficiency is made up either the patient is still in shock or the renal injury is severe and death from uremia in six to ten days is not unlikely This occurs especially in crush injuries

Other Therapeutic Measures

Oxygen therapy in shock is probably useless because the arterial blood is already saturated The low venous oxygen concentration in shock is due to deficient velocity of flow in the capillary circulation

All pressor drugs are useless, for while they raise blood pressure they do not increase cardiac output or improve capillary flow

Conserving heat (blankets) is desirable but adding heat (hot water bottles) is harmful, since this produces a deviation of blood to the periphery from the central circulation and because the locally

heated tissues do not have the oxygen with which to meet the increase in metabolic demand created by the heat High environmental temperatures are deleterious

The head down position (ten to fifteen degrees) probably helps by increasing cardiac output, but it cannot be used when there is respiratory embarrassment

In shock the intestine cannot absorb fluids or food well It is therefore useless to force alimentation until absorptive capacity is restored, i e , until normal blood flow in the gut is restored

The blood changes in shock are as follows oxygen in venous blood is low (5 volumes per 100 cc instead of 14 volumes per 100 cc), circulation time is slowed, pyruvic, lactic and amino acids are increased Phosphorylation in tissues, which is necessary for carbohydrate metabolism, is deficient Because the blood becomes more acid, alkali has been recommended Its value is dubious

All of these changes revert to normal if shock is treated early and effectively But, as stated, if the one important therapeutic agent, i e , blood or blood substitute, is not given in time, neither it nor any other known agent will reverse the process of rapid disintegration and death If the blood volume loss has been replenished, i e , if at least 1500 to 2000 cc of blood has been given, and recovery is not in evidence, the lack of response indicates that (1) blood volume loss is continuing or (2) the shock state is beyond recovery or (3) the shock is due to some other factor than blood volume deficiency If it is certain that blood volume loss is not continuing, the administration of more blood will produce a harmful plethora, such as pulmonary edema or intestinal hemorrhage

When the need of blood is so urgent that minutes count in restoring the circulation, utilize a transfusion kit with which blood can be given under pressure very rapidly

The foregoing principles of therapy are based on intensive clinical and laboratory study of the shock state Theories to explain the fundamental pathology have undergone substantial revision * The concept of increased capillary permeability is now considered invalid The central defect in the circulation is not due to cardiac failure, but to a peripheral loss of vascular tone with stagnation resulting in death from tissue anoxia The loss of tone is as yet unexplained There is some basis for the view that it is due to a toxin derived from the anoxic liver There is a growing belief that liver failure is involved in the disintegrating process of shock, whether a toxin is or is not involved †

* Fine J Frank H A Seligman A M Annals of Surgery *122* 652 1945
† Fine J Frank H A Seligman A M Annals of Surgery *126* 1002 1947

of extensive burns plasma and extracellular fluid are lost in large amounts These must be supplied at once Because anemia develops rapidly, whole blood will be needed within twenty four hours to replace red cell as well as plasma loss or to anticipate red cell loss Only when the hematocrit (i e , blood viscosity) is very high will plasma alone be preferable, since the high viscosity reduces the already lowered cardiac output Even then, whole blood is used if plasma is not available, since the most important need by far is that of volume replacement (2) For hemorrhage whole blood is necessary, of course Plasma is not used unless blood is not available If neither blood nor plasma is available a 6 to 8 per cent solution of sterile gelatin is satisfactory, but not if more than 1500 cc is needed Gelatin may produce a transient renal injury Glucose and salt solution are not to be relied upon for replacement of blood volume deficiency They are often needed as supplements to replace extracellular fluid loss, if this exists at the same time, as in burns (3) In shock due primarily to dehydration, as in diabetic coma, saline solution with added glucose is essential If there is acidosis, add sodium lactate (see Fluid and Electrolyte Therapy) In severe dehydration there is some plasma loss, so that plasma or whole blood may also be given

If shock is due to blood volume loss, the signs which indicate that the blood or plasma which has been given is enough are a warm dry skin, return of normal color, normal blood pressure, a slowing pulse rate and return of a normal urine output

One seldom errs on the side of too much blood or plasma, but too much saline solution can cause pulmonary edema If diuresis does not occur in response to adequate fluid administration, forcing more fluid is not only useless, since the kidney will not respond but severe harm will result from pulmonary edema If anuria or oliguria persists after volume deficiency is made up either the patient is still in shock or the renal injury is severe and death from uremia in six to ten days is not unlikely This occurs especially in crush injuries

Other Therapeutic Measures

Oxygen therapy in shock is probably useless because the arterial blood is already saturated The low venous oxygen concentration in shock is due to deficient velocity of flow in the capillary circulation

All pressor drugs are useless, for while they raise blood pressure they do not increase cardiac output or improve capillary flow

Conserving heat (blankets) is desirable, but adding heat (hot water bottles) is harmful, since this produces a deviation of blood to the periphery from the central circulation and because the locally

some other restrictive appliance will do this It is well to remember that rest of an area in an extremity means immobilizing the joint above and below the involved area

2 Relieve tension in the infected area Surgery can do this by making a vent in the area, but not until the infection is first localized and pus has accumulated Incisions into areas of cellulitis or lymphangitis are bad surgery, since tension is not relieved, septic products are not evacuated and further trauma is inflicted To find the area to be incised, test for fluctuation by ballottement (occasionally by aspiration) and define the *area of maximum tenderness* If both are present, the two should coincide, but the latter is the more reliable and more constant sign Limit your incision to this area When there is infection in a closed space, e g , a felon, the mid palmar space or cellulitis of the floor of the mouth ("Ludwig's angina"), incision is necessary for relief of pressure before fluctuation can be demonstrated

3 Once a vent has been made, keep it open with a drain until the discharge has become serous or has stopped altogether

4 Do not squeeze or otherwise traumatize an infected area

5 Heat (see section on Wound Sepsis)

6 Chemotherapeutic agents The remarkable effect of antibiotics on pathogenic organisms has eliminated or reduced the need for surgery in some types of infection that were formerly amenable primarily to surgical intervention e g , empyema, mastoiditis, acute osteomyelitis Moreover, many of those infections which still require surgery have become much less formidable problems because local and general dissemination (bacteremia, septicemia) are effectively inhibited by antibiotics Nevertheless, reliance upon antibiotics as a substitute for surgical principles that are valid should not be countenanced It is clear that antibiotics have their limitations and, alone, will in many circumstances fail to produce the maximum speed and completeness of cure which a judicious combination of proper surgical technic and chemotherapy are capable of doing In chronic osteomyelitis, for example, antibiotics alone are futile If proper surgery is first performed, i e , removal of sequestrum, elimination of dead space and firm closure of skin, antibiotics are useful to assist healing by decreasing the bacterial load on the tissues

CHEMOTHERAPY

Chemotherapy is valuable for the following conditions

1 Cellulitis, lymphangitis, bacteremia, acute osteomyelitis, suppurative arthritis, pleuropulmonary infections, furunculosis, carbuncle and spreading peritonitis

CHAPTER 5

SURGICAL INFECTIONS

Surgical infections are those in which surgical technics are required for effective treatment Usually surgical treatment is applicable when bacteria produce localized necrosis or suppuration in accessible locations The recent advances in chemotherapy have eliminated or sharply reduced the incidence of certain surgical infections, as post pneumonic empyema, mastoiditis and acute osteomyelitis

Invasion by pathogenic bacteria is followed by localized or spreading infection, depending on the resistance of the host and the virulence and invasiveness of the bacteria But mechanical forces and the movement of fluids and phagocytes containing organisms through lymph and vascular channels help disseminate infection This is why immobilization of the infected part as well as the body is an essential part of surgical therapy Though immobilization is a therapeutic principle of great importance, it is all too often ignored

Cellulitis and lymphangitis are examples of spreading infection which progress by continuity Tension in the infected area is important not only as a cause of pain, but also as a cause of spread of infection by continuity The spread is in the line of least resistance, usually along fascial planes Tension also shuts off capillary flow, helps to produce thrombosis of vessels and therefore necrosis of tissue

The general response to infection may be profound and the local reaction slight or vice versa A chill means blood stream invasion Fever is the response to split proteins of bacterial or tissue origin The increased catabolism and anorexia cause loss of nutritional reserves and wasting Dehydration and incomplete oxidation produce water and acid base imbalance and damage to perhaps already damaged kidneys

The principles involved in the treatment of major sepsis also apply to minor sepsis, which by neglect or ignorant meddling is all too often converted to major sepsis These principles which one will do well to observe constantly, follow from the foregoing statements and are as follows

1 Localize the infection if it is not already localized To do this, rest the patient or the part or both A bed, a sling, a splint, a cast or

Less common manifestations are hepatitis and hemolytic anemia Treatment of toxic reactions requires stopping the use of the drug *plus* measures appropriate to the system affected Another sulfonamide may be employed, but the risk of toxicity will remain higher than in the normal

Laboratory control of therapy requires hemoglobin and white blood count three times weekly, a urinalysis daily and nonprotein nitrogen determinations in all patients with high dose therapy The latter is done daily in all patients with oliguria or hematuria The sulfadiazine blood level, when high dose therapy is required, should be determined three times weekly It should be maintained at 15 mg per 100 cc

Indications The sulfonamides are the treatment of choice in the following conditions

(1) Meningococcal meningitis and meningococcemia Use the drug parenterally and terminate treatment three to five days after the patient is completely afebrile

(2) Colon bacillus pyelonephritis Give 2 to 4 grams initially and 1 gram every four hours Streptomycin is probably superior to sulfonamide

(3) Bacillary dysentery Give 2 grams initially and 1 gram every six hours Sulfathalidine or streptomycin may also be effective

(4) Lymphogranuloma inguinale Give 4 grams initially and 1 gram every four hours

Sulfonamides are used as adjuvant therapy to penicillin in pneumococcal, streptococcal and staphylococcal meningitis Treatment is terminated seven to ten days after clinical recovery

Other sulfonamides are indicated if there is a toxic reaction to the first sulfonamide used before complete recovery has taken place or if there is a poor response to adequate dosage *Sulfamerazine,* in dosage of 4 grams initially and 1 gram every four hours, will give blood levels of about 16 mg per 100 cc It may be used instead of sulfadiazine at high dose level *Sulfathiazole,* in the same dosage as sulfadiazine, will produce lower blood levels An effort should be made to maintain a level above 6 mg per 100 cc for serious infections such as meningitis There is growing evidence that *sulfamethazine* is not only less toxic but more potent than sulfadiazine for most organisms

In order to reduce renal injury one may administer the total dose of sulfonamide by combining two or three types (sulfadiazine, sulfathiazole and sulfamerazine) so as to reduce the effective concentration of any one to a safe level, while maintaining the full level of the

2 For prophylaxis after secondary closure of major wounds of soft parts, compound fractures and heavily contaminated operative wounds

Chemotherapy is properly combined with surgery in acute appendicitis with peritonitis, infections of the hand and foot with or without diabetes, in bronchiectasis, chronic empyema, pulmonary abscess, gas gangrene, chronic osteomyelitis, in chronic granulomas, including actinomycosis, and after surgery to prevent the spread of infection and pulmonary sepsis

Combinations of antibiotics are of value *Penicillin* and *streptomycin* may be used together logically if there is mixed infection due to gram positive cocci or bacilli and gram negative bacilli—as in peritonitis Multiple agents should not be used unless the types of bacterial flora justify them The chief use for added sulfonamides is in meningitis, because of their ability to penetrate into the cerebrospinal fluid A combination of streptomycin and sulfonamides has been shown to be useful in brucellosis

Sulfonamides

Among these *sulfadiazine* is in most cases the drug of choice because it is highly effective and the least toxic A maximum dose—4 to 6 grams—is given immediately One gram every four hours is given thereafter The initial dose may be given intravenously to avoid the possibility of vomiting It is dissolved in a liter of normal saline solution to avoid renal complications Subsequent intravenous doses should be given at six hour intervals in 5 per cent solution As soon as the patient can retain the drug by mouth it is given at four hour intervals This dosage aims at a blood concentration of 12 to 15 mg per 100 cc If the patient is dehydrated, administer one or two liters of fluid intravenously before giving a sulfonamide

Lower dose levels range from 4 grams immediately and 1 gram every four hours down to 2 grams immediately and 1 gram every six hours

Toxic reactions are as follows

Renal toxicity in the form of tubular nephrosis or urinary calculi is the commonest important toxic reaction It should be prevented by reasonable dosage and adequate fluid intake and urinary output Sodium bicarbonate 15 gm daily, will help to avoid calculus formation, but it also increases the excretion of sulfadiazine and lowers its concentration in the blood

Agranulocytosis may occur after seven to ten days of treatment Drug rash and fever may occur

tic streptococci and gonococci, which are almost always highly sus ceptible Organisms of borderline or variable sensitivity such as the staphylococcus, or streptococcus viridans, or any uncommonly treated infection should have sensitivity determinations made, par ticularly if the infection is a serious one

Determination of the penicillin serum level is indicated chiefly when high levels are desired, as in treatment of subacute bacterial endocarditis

Four grams every 4 hours of 4 carboxyphenyl methane sulfon-anilide ("caronamide") by mouth may be used to block the tubular excretion of penicillin when especially high levels of penicillin are desired Half this dose is sufficient for patients over sixty years of age It enhances the effectiveness of penicillin given orally also, so that highly susceptible organisms can be effectively destroyed by oral penicillin therapy "Caronamide" not only increases the blood level, but sustains and prolongs the curve of declining concentration so that less frequent than the usual administration of parenteral pen icillin may be possible Occasional nausea and drug rash is caused by this drug

Reactions to penicillin are rare Occasional urticarial skin erup tions occur If severe, 1 gram of novocain in 500 cc of saline, given intravenously over a period of ten hours, or pyribenzamine, may help Rarely more serious skin reactions such as exfoliative dermatitis may occur

Penicillin is the treatment of choice in infections due to

(1) Beta hemolytic streptococci	25 000 unit dosage
(2) Pneumococci	25 000 unit dosage
(3) Gonococci	25 000 unit dosage
(4) Staphylococci	50 000 unit dosage
(5) Alpha hemolytic or nonhemolytic streptococci	Particularly subacute bacterial endocarditis—treat to maintain blood level 5 to 10 times the bacteriostatic dose for 4 to 6 weeks

(6) Spirilla Leptospira and Spirochetal infections
 (a) Syphilis—primary or secondary—60 injections of 90 000 units every three hours for a total of 5 400 000 units

Penicillin is combined with sulfadiazine in meningitis due to pneumococcus, streptococcus and staphylococcus

Penicillin is combined with antitoxin in diphtheria

It is now and then worthwhile to disregard recommended doses and to administer unusually large doses at the outset in order to eliminate a very virulent infection In peritonitis penicillin combined with sulfadiazine or streptomycin may be used with benefit Peni cillin is worthwhile for prophylaxis against postoperative pulmonary

active radical The total solubility of such combinations in urine is greater than the sum of the individual solubilities and thereby reduces the chances of crystalluria

In cystitis, sulfamethazine is superior to sulfadiazine and may be effective for gram positive or gram negative organisms which have failed to respond to penicillin or streptomycin

It is essential for maximum activity of sulfonamides that the urine be made alkaline This cannot be done unless some 12 to 20 grams of sodium bicarbonate is administered daily The more alkaline the urine the less sulfonamide is required to achieve a sterile urine It is possible to produce mild edema from sodium retention due to such alkali dosage, but this may be risked in severe cases of infection of the urinary tract

Penicillin

For infections with less susceptible organisms, such as the staphylococcus—50,000 units are given every two to three hours intramuscularly Treatment is continued until the temperature has been normal for four to five days Then 10,000 to 20,000 units are given every three hours for five to ten days

For infections with more susceptible organisms, such as the streptococcus and pneumococcus, 25,000 units every three hours intramuscularly will suffice as a rule Treatment is continued until the temperature has been normal two to three days, then decreased to 10,000 units every three hours for three to four days

Special Therapy Since the drug does not appear in spinal fluid, intrathecal plus parenteral therapy is required in meningitis Use 10,000 units in 10 to 12 cc saline intrathecally after the withdrawal of a slightly larger amount of spinal fluid once a day Penicillin may rarely cause central nervous system injury, such as meningeal irritation, paresis of the legs or bladder palsy

In pleuritis and pericarditis a daily injection of 100,000 to 250,000 units of penicillin in 25 to 50 cc of saline into the cavity is made In suppurative arthritis 25,000 to 50,000 units are injected into the joint every other day Therapy is continued for one week after bacteriological cure Additional parenteral treatment is given for accompanying systemic infection

In suppurative bronchitis aerosol inhalations supplement intramuscular therapy, although it is not demonstrated that the drug reaches the inflamed area directly

Control of Therapy The penicillin sensitivity of infecting organisms need not be determined in the case of pneumococci, hemoly

Intrapleural treatment in addition to parenteral treatment is desirable in cases of empyema—0 5 to 1 0 gm daily

Inhalation may be of value in chronic pulmonary suppuration A dose of 500 mg daily given over a twenty four hour period in a concentration of 50 mg /cc may be used

In preparing the bowel for surgery or where postoperative control of contaminating organisms from the intestine is desired, streptomycin 1/4 gram orally q i d for several days will be useful to reduce gram negative organisms

For control of therapy it is desirable, whenever possible, to test all organisms for their sensitivity to streptomycin in order to insure that adequate dosage is used from the start Many organisms quickly become resistant to the drug and it is therefore important that a maximal effect be obtained at the outset

The most important complications are skin eruptions (usually a cause for discontinuing the drug), vertigo, tinnitus and deafness These symptoms usually appear after three weeks of treatment but often much earlier It is important to remember that 1 to 2 grams daily is much less toxic and probably just as effective as 3 to 4 grams daily The eighth nerve injury may be irreversible and is usually an indication for discontinuing the drug

Lesser reactions are local pain and tenderness, headache, fever, tachycardia, fall in blood pressure and flushing of the skin

The indications for its use are as follows

Group I—definite indications Tularemia, *H influenzae* infections of all types, meningitis, bacteremia or urinary infection due to *E coli, B proteus, B Friedlander, A aerogenes, B pyocyaneus* and *B tuberculosis,* lymphogranuloma inguinale

Group II—probably helpful peritonitis, empyema, liver abscess, endocarditis or chronic pulmonary infection due to gram negative bacilli and Friedlander pneumonia

Group III—of questionable value typhoid and paratyphoid infections, brucellosis

Local Application of Antibiotics

In traumatic and surgical wounds reliance on the local application of these drugs without parenteral administration, wherever chemotherapy is indicated, is unsafe Parenteral therapy alone generally will achieve whatever chemotherapy with these drugs can achieve except (1) when it is desirable to control the bacterial population of the intestinal tract, in which case sulfathalidine and streptomycin may be used to reduce the gram positive anaerobes, *E coli* and other

complications in combination with sulfadiazine or streptomycin When wounds are either infected or have been contaminated with a mixed flora containing anaerobes, or gram negative organisms as well as gram positive organisms penicillin is combined with sul fadiazine or streptomycin Penicillin is more effective than the other antibiotics against anaerobes

Penicillin orally may be effective for Vincent's angina and other local infections, but its uncertain stability and absorption from the gastro intestinal tract makes it unreliable for systemic infections, even in large doses

In cases where penicillin is given for prophylactic purposes or for mild or residual infections, it may be proper to reduce the interval of administration from every three to every eight hours While this should not be done in virulent or acute sepsis, it is feasible for mild sepsis or prophylaxis because the action of penicillin upon bacteria *is still bacteriostatic even while the blood levels have fallen below ac* cepted therapeutic concentrations

An alternative to ordinary penicillin, which is becoming increas ingly acceptable, is crystalline procaine penicillin G in water, with sodium carboxyl, methyl cellulose as a dispersing agent This sub stance, given in a single dose of 300,000 units will produce a thera peutically effective blood level for twenty four hours in most patients In more virulent infections it may be given every twelve hours This should be adequate for all except unusual cases The same dose of this compound, suspensed in oil and combined with aluminum mon ostearate as a stabilizing emulsion, is said to produce a therapeutic level for ninety six hours

Streptomycin

For routine parenteral therapy 1 to 3 grams daily in divided doses is given intramuscularly every three to four hours Relatively sus- ceptible infections such as those due to *B tularemia* and *H in- fluenzae* usually respond to 1 to 2 grams daily Cases of gram negative bacillus bacteremia or peritonitis should receive 2 to 4 grams daily

Urinary infections due to gram negative bacilli require 1 to 3 grams daily, 1 gram usually being adequate *The urine must be made alkaline with 6 grams each of sodium bicarbonate and sodium citrate daily in divided doses*

In general, treatment is continued for five to ten days Procaine may be used to decrease the pain of injection

Special Therapy Intrathecal treatment is required in addition to parenteral treatment in all cases of meningitis Fifty mg dissolved in 5 to 10 cc of sterile salt solution is given once daily for seven days

Polymyxin cannot be given in unlimited quantities It produces a transient proteinuria, occasional azotemia and rarely a transitory oliguria But these effects, due apparently to tubular damage, can in large degree be obviated by concomitant oral administration of d 1 methionine in five to ten times the dose of the antibiotic One British preparation, "Aerosporon B," does not injure the kidney and does not require methionine

While the clinical potentialities of this antibiotic for the control of pulmonary, peritoneal, intestinal and genito urinary infections due to gram negative organisms are extremely promising, they must be regarded as tentative until more observations will have been made

Bacitracin

Bacitracin is a new antibiotic obtained from a strain of *B subtilis*, which is effective against many gram positive cocci, Actinomyces, the bacteria of human bites, the mixed flora of synergistic gan grene, certain anaerobes and spirochetes It does not act upon gram-negative bacteria The toxic action on the kidney of earlier prepara tions is being reduced by more refined processing technics It is not inactivated by organisms which produce penicillinase, it is more slowly excreted than penicillin and is given every six hours in doses of 10,000 to 30,000 units Therapeutic results are obtained by local application in solution or ointment form to septic wounds due to organisms especially susceptible to this drug, which is said not to be locally irritating

Mode of Action of Antibiotic Agents

The mode of action of useful antibiotic agents is subtle and obscure These agents do not inhibit most vital enzymatic reactions of living organisms They indicate their activity only by causing cessation of bacterial growth However, some clues to their mechanism of action are available

Sulfonamides The most widely held view is that sulfonamides act by competing with paraminobenzoic acid as a substrate for an enzyme which catalyzes a vital biochemical process In a few organisms this process appears to be the synthesis of folic acid, but this latter mechanism is by no means universal

Penicillin A recently demonstrated relation between penicillin and the amino acid metabolism of bacteria suggests that the mecha nism of action of this antibiotic is its ability to inhibit the assimilation and concentration of free glutamic acid within gram positive bacteria, which apparently require this acid to synthesize protoplasm

gram negative organisms, (2) in Vincent's angina where penicillin by mouth is effective, (3) in empyema, meningitis, pericarditis and suppurative arthritis, in which access of the antibiotic from the circulation to the area is impeded and therefore insufficient, (4) in open wounds in which blood supply is deficient because of vascular thrombosis

The local effectiveness of antibacterial agents is limited by (1) their solubility in body fluids, (2) inhibition by necrotic tissue, pus or blood or the action of resistant contaminating bacteria The sulfonamides are relatively insoluble, irritating and inactivated by necrotic tissue Penicillin is inactivated by penicillinase from coliform bacteria and resistance to streptomycin develops very quickly In special circumstances other local chemotherapeutic agents may be tried Tyrothricin, zinc peroxide, azochloramide and "Bacitracin" (see p 51) have their uses for local bacteriostasis * Antibiotics, when used locally, are applied in concentrations of 1000 units per cc of solution or per gram of water soluble ointment A solution of 10 per cent urethane combined with solutions of antibiotics has been found useful in the local treatment of septic wounds due primarily to gram negative organisms

Polymyxin

This remarkable antibiotic has recently been isolated from the soil bacterium *B polymyxa* British investigators have isolated an almost identical substance from *B aerospora* This compound is a heat stable and acid stable basic cyclic polypeptide containing a C^9 fatty acid with a molecular weight of about 1200, which has astonishing bactericidal properties *in vivo* as well as *in vitro* against the following gram negative organisms *E coli, B typhosus,* and other enterococci, *K pneumoniae, V cholera, H influenzae, H pertussis, B pyocyaneus, Brucella melitensis,* etc *B proteus,* unfortunately, is much more resistant than other gram negative organisms Moreover, bacterial resistance to this compound has not been observed It is bactericidally effective when given subcutaneously or intramuscularly It is also effective by the oral route, but the dose required may prove to be larger than by other routes The average parenteral dose is 3/8 mg per kg body weight every three hours or 1/2 mg per kg body weight every four hours Septic urine may be sterilized within twenty four hours and the stool is totally freed of gram negative organisms within the same time Like penicillin it does not penetrate the meninges

* Woods D D Annual Review of Microbiology Vol 1 115 1947

one another, forming a multilocular abscess It is fairly common in diabetics With penicillin it is possible to limit the spread of, and even abort, a carbuncle Often incision is not required, though fluctuation is an indication for drainage The former practice of mutilating, ex tensive incisions and undercutting are no longer necessary Neglected carbuncles may assume dangerous proportions and bacteremia with metastatic foci may result Immobilization when possible is an aid in the treatment Local injection of penicillin about the involved area has been advised, but this is not as effective as parenteral adminis tration Radiation therapy is said to be useful to abort a carbuncle or to facilitate its liquefaction *

Osteomyelitis

Acute hematogenous osteomyelitis almost always occurs in the epiphyseal end of a long bone in children and young adults and is usually due to the hemolytic staphylococcus Trauma frequently initiates the acute infection, especially in a child with an existing focus of infection There is always a septicemia or bacteremia Localizing signs may or may not be present at first

Treatment Penicillin or sulfonamides in maximum dosage usually stops the infection before necrosis occurs Immobilize the extremity in a cast, including the joint above and below the affected region Blood transfusions, may be helpful Most patients will either abort the infection or localize a subperiosteal abscess, which can then be safely drained If suppurative arthritis occurs, repeated aspirations and local injection of antibiotics are indicated before resorting to arthrotomy

Actinomycosis

Actinomycosis, a disease especially likely among farmers growing grain, always invades via the mouth, e g , from straw held in the mouth From here it invades the tongue, tonsil, cheek, parotid or cervical nodes or the lungs or intestine (especially the cecum) The process breaks through into surrounding tissues, producing sinuses and fistulas in the abdominal wall, chest wall or neck The tissues are hard and indurated, suggesting tumor or tuberculosis The spread is not as a rule related to lymph pathways, as is the case in tuberculosis, which does not produce the wooden feel and purple discoloration characteristic of actinomycosis Finding the sulfur granules charac teristic of the ray fungus confirms the diagnosis Good nutrition, po

* MacKee G M X rays and Radium in the Treatment of Diseases of the Skin Lea and Febiger Philadelphia 1938 p 428

Streptomycin There is no good explanation for the activity of this agent Its effectiveness may be neutralized by lipositol, a phospholipid present in brain and soy beans Because streptomycin is reduced by certain compounds such as urea, pyrimidines and purines, it has been suggested that streptomycin acts by blocking the intracellular synthesis of purines or pyrimidines

Furuncle, Boil

A furuncle or boil is a localized staphylococcal skin infection, centering about a hair follicle, which takes a characteristic course, terminating in healing after extrusion of a slough or core

Furunculosis flourishes on the face, buttock, perineum and axilla Mechanical dissemination of the discharge is the cause of the spread, but the axilla, perineum and perianal regions are especially susceptible because of sweating and high *p*H of the skin secretions, which facilitate bacterial growth Acidifying lotions containing a bacteriostatic agent, plus parenteral antibiotics in obstinate cases, constitute the best therapy Minimizing local maceration, mechanical friction and careful cleansing are helpful also Obviously the patient's hands should not make contact with the area An occlusive dressing is therefore often necessary

Incision of boils, unless fluctuant, is unnecessary and may be meddlesome Drainage may sometimes be facilitated and pain relieved by inserting through the tiny opening on the top of a fluctuant boil a fine probe dipped in pure phenol The urine should be examined for glucose in patients having boils Cleanliness and avoidance of contact with a discharge from a boil will reduce the number of satellite infections An effective bacteriostatic ointment such as furacin ointment, and parenteral chemotherapy when indicated, is useful in preventing recurrence Immobilization of the involved area when possible, is helpful Rarely a furuncle initiates a bacteremia and serious metastatic infection, such as osteomyelitis or perinephric abscess When a boil occurs on the face, especially on the lips, nose, chin or cheek, it is potentially dangerous since infection may spread from it through the emissary veins to involve the cavernous sinus in a septic thrombophlebitis Formerly this complication was nearly always fatal Now it is rarely seen with the timely use of effective chemotherapy Squeezing a boil anywhere, particularly on the face, is extremely hazardous

Carbuncle

A carbuncle is an infection of the skin and subcutaneous tissues in which multiple pyogenic foci connect deep under the surface with

Human Bites

Human bites are more dangerous than those of other species (except for snakebite or the bite of a rabid animal) because of the pathogenicity of the mixed flora of the human mouth Such bites should be thoroughly débrided and never sutured for primary wound healing, but left open to granulate Vigorous antibiotic therapy will be necessary if infection sets in

Lymphogranuloma Inguinale

Lymphogranuloma inguinale is a chronic granulomatous disease of venereal origin caused by a virus which produces inguinal lymphadenopathy, granulomas and indolent ulcers There is some discomfort, but no severe pain The disease is more common in Negroes than in white people A small penile lesion is the usual portal of entry of the virus in the male The more chronic lesions may involve skin, muscle, bone and intestine Lesions in the mouth have also been reported In the female the initial lesion on the cervix most often passes unnoticed, but the pelvic, particularly the perirectal lymphatics, may ultimately become involved and lead to rectal stricture This lesion may be confused with carcinoma The diagnosis of lymphogranuloma inguinale is made by obtaining a positive skin reaction to Frei's mouse brain antigen The treatment is empirical Antimony, used in the past, is ineffective but chemotherapy with sulfadiazine or, better, streptomycin is effective "Duomycin," a recently introduced antibiotic, is said to be very effective against this disease as well as against certain viral and rickettsial infections Surgery is at times necessary for complications such as rectal stricture and intestinal obstruction

Tetanus

The *Clostridium tetani* is a highly lethal organism which is an obligatory anaerobe usually present in the intestine of the horse and frequently of man Harmless on skin, it multiplies rapidly in tissue, especially damaged tissue It remains locally, unless dispersed by the exudate from a contaminating pathogen or other foreign body If present alone or in the absence of damaged tissue, it may remain dormant until lighted up by injury Its exotoxin travels along motor nerve sheaths to anterior horn cells, lowers the threshold of the sensorimotor reflex arc, with resulting tonic and clonic spasms of muscles innervated by the affected nerves and later of distant muscles whose nerves are involved by vascular distribution of the exotoxin Muscles with the shortest nerve trunks, i e , the masseter, facial,

tassium iodide and penicillin may effect a cure Wide surgical excision, where feasible, may also be helpful if combined with these measures

Gas Gangrene

This infection is caused by obligatory anaerobes of intestinal origin which, if heavily inoculated into damaged tissue, produce gas and rapid necrosis These organisms seldom flourish in healthy tissue and they are usually made virulent by contaminating coccal pathogens The disease is, therefore, found in dirty civilian or military wounds in which extensive injury exists and in which dirt containing human or animal excrement is implanted That a badly infected wound with muscle damage may be harboring gas bacilli is to be assumed if the wound is especially painful or if the patient is restless and apprehensive Wounds of the leg and buttock are most susceptible, perhaps because the organisms can be commonly found in large numbers on the skin of these areas

Three fourths of the cases are due to *Clostridium welchii,* the rest to *B edematiens* or *vibrion septique* All these may be present together with the streptococcus or other aerobes Once the infection starts, it spreads by contiguity to neighboring healthy muscle, dissecting its way along fascial planes and remaining confined to one or more muscles or groups of muscles, developing gas which can be detected by crepitation or by an x ray film showing gas bubbles Other tissues may be involved without involvement of muscles The wound and neighboring tissues show edema, crepitation, a serosanguineous exudate and sometimes bullae, discolored, brown, violaceous or blackish skin, as well as deep necrosis These patients show a high fever, extreme toxemia, a rapid pulse and go into shock quickly They require emergency treatment which consists in massive doses of antitoxin, antibiotics and surgery While antitoxins are probably of some value, there is no way of determining the dose required or its effectiveness if combined with other therapy Massive doses of penicillin and sulfonamides are of considerable value and may be sufficient to control milder degrees of infection If not, wide spread incisions to open involved areas, resecting all affected tissues such as muscle bundles regardless of their functional value, or amputation may be the only way to save life

The finding of these organisms in sluggish wounds is properly interpreted as a contamination by avirulent strains When found in infected wounds, the latter should be debrided and, if possible, drained

pain, or evidence of marked localized tension with a point of maximum tenderness indicative of underlying pus Pain is not greatly increased on motion *Incision should not be made for this condition* If incisions are erroneously made the infection may spread to a joint, tendon sheath or fascial space or perhaps to all three Most cases will subside without residual disability if proper treatment is instituted early This treatment should be rest in bed, elevation and immobilization of the extremity, and chemotherapy The immobilization must be adequate, i e, it must include the whole arm, using a splint board preferably Heat therapy is not needed

Tendon Sheath Infection Tendons have a meager blood supply The tension in an infected tendon sheath, therefore, is often sufficient to devitalize the tendon rapidly Early relief of tension is imperative The pain of tendon sheath infection is severe and throbbing The finger is held in a semiflexed position, which allows maximum space in the sheath Extension of the finger or direct pressure over the tendon is very painful Though chemotherapy should be used, immediate drainage is imperative The type of incision is important Usually midlateral incisions avoiding the flexion creases are best Drainage material should not be in contact with the tendon Petrolatum gauze is best This is removed after one or two days Warm wet dressings might be desirable, except that they facilitate secondary infection and are best dispensed with Immobilize the arm after operation and elevate the extremity to reduce edema If drainage is adequate, frequent dressings are not necessary or desirable

Fascial Space Infection The two most important fascial space infections are the *midpalmar* and the *thenar* The fascial spaces of the hand are infected by penetrating wounds or by extension from neglected cellulitis or undiagnosed tenosynovitis These spaces lie under the flexor tendons and anterior to the muscles which cover the metacarpals Pus from the distended fascial spaces may rupture into connecting spaces in the forearm The primary site of injury frequently suggests which of the two fascial spaces is likely to be involved However, the *diagnosis of midpalmar space infection is based primarily on one finding, i e, bulging of the normal concavity of the palm* There is severe tenderness over the bulge, nontender swelling of the dorsum of the hand, fever, and pain on motion of the fingers In *thenar space infection* soreness and swelling in the thenar area is accompanied by swelling and maximum tenderness over the middle third of the metacarpal of the index finger

The treatment of fascial space infection is early adequate incision The incisions should not cross the major creases at right angles or

trapezius, constrictors of the pharynx and the muscles of the back are involved early The clinical picture of lockjaw is due to tight masseters The patient also feels stiffness in the muscles of the cheek, throat, neck and back, so that arching of the back, a risus sardonicus or inability to swallow betray the existence of the disease If the incubation period is less than five days, the disease is nearly always fatal and if longer, 50 to 60 per cent fatal Nothing can be done to influence the exotoxin The wound itself, if accessible, should be opened wide, foreign bodies, if present, removed, exudate drained If necessary, a dispensable portion of the body such as a toe or finger may be amputated Simultaneously, antitoxin in hundreds of thousands of units may be needed and given by intramuscular and intravenous routes Its effectiveness is not demonstrated To control spasms, magnesium sulfate or curare may be useful Sedatives such as pentothal or avertin are also used

Prophylactic control is of course the wise procedure The kind of wound which is susceptible to tetanus is one contaminated by garden soil, manure or feces, and which was inadequately debrided when first treated or was neglected altogether Puncture wounds which remain unopened are especially dangerous The rusty nail wound is typical It is a foreign body plus the *Clostridium tetani* in a closed wound which sets the stage Tetanus toxoid is a remarkably effective means of producing immunity An immunized person should get a booster dose of toxoid (1 cc) on receipt of a wound A nonimmunized person is given a 1500 unit dose of antitoxin as soon as a wound is inflicted Sensitivity to horse serum must be determined in advance and desensitization performed, if necessary

The Septic Hand

The septic hand generally is not treated well and much permanent disability is due to improper treatment The three commonest serious hand infections are acute lymphangitis, tendon sheath infection and fascial space infection Less serious but important hand infections are paronychia, felon, furuncle, carbuncle and subepithelial abscess

Acute lymphangitis is the most frequent of the serious infections and is important because the wrong diagnosis and treatment may do serious harm It follows a trivial penetrating injury, is marked by chills, fever, malaise and restlessness The hand becomes red, hot and swollen Marked edema is present on the back of the hand Red streaks appear up the forearm and the regional glands enlarge It is important to remember that there is no boring or throbbing

pain, or evidence of marked localized tension with a point of maximum tenderness indicative of underlying pus Pain is not greatly increased on motion *Incision should not be made for this condition* If incisions are erroneously made the infection may spread to a joint, tendon sheath or fascial space or perhaps to all three Most cases will subside without residual disability if proper treatment is instituted early This treatment should be rest in bed, elevation and immobilization of the extremity, and chemotherapy The immobilization must be adequate, i e, it must include the whole arm, using a splint board preferably Heat therapy is not needed

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The treatment of fascial space infection is early adequate incision The incisions should not cross the major creases at right angles or

cut major arteries, nerves, tendons or annular ligaments Chemotherapy, elevation, immobilization, sedative and supportive therapy are of course indicated

Furuncle and Carbuncle of the Hand Furuncles and carbuncles commonly occur on the hairy areas of the dorsum of the hand and fingers There is marked edema Lymphangitis is frequent Incision is usually not necessary Immobilization and chemotherapy, with or without hot soaks, will ordinarily cause subsidence or spontaneous drainage of the infection Look for diabetes

Subepithelial Abscess A common superficial infection from a minor penetrating wound is often manifest as a septic blister on the distal part of the finger During its formative period it should not be mistaken for felon or paronychia, since erroneous incision will disseminate sepsis Simply uncap the blister widely and apply a finger splint and ointment dressing

Felon This is an infection of the distal closed space of the finger in which great tension develops Throbbing pain is enough to prevent sleep Early incision is required *Do not wait for fluctuation,* for necrosis of bone rapidly occurs because of the great tension The incision is a hockey stick type on one or both sides of the distal portion of the finger Insert a soft drain, that is, petrolatum gauze or rubber dam, splint the whole hand and forearm, apply a sling and use analgesics as required If the phalanx is necrotic the incision will not close until sequestrum is discharged Do not attempt to excise the sequestrum Let it extrude spontaneously

Paronychia Paronychia is treated by removal of the base of the nail through two longitudinal incisions, which slant toward the lateral aspects of the finger, with undermining of the intervening tissue Occasionally the entire nail is removed A petrolatum gauze dressing and finger splint are applied At times tiny abscesses beneath the cuticle can be drained by inserting the point of a No 11 Bard Parker blade gently Anesthesia is not needed

General Rules for Treatment of Hand Sepsis Use general anesthesia for drainage of all important hand infections Pentothal is often satisfactory The operation should be done in the operating room Use an inflated blood pressure cuff to obtain accurate visualization of the lesion Rubber should not be used in drainage of tendon sheaths Drains should be removed after twenty four to thirty six hours Hot soaks are usually avoided as they produce edema and maceration Always splint the hand and arm in the position of optimum rest Give penicillin 50,000 units at once and 30,000 units every three hours

SECTION II

Regional and Special Surgery

CHAPTER 6

BURNS

IMMEDIATE CARE

Immediate care is best given in an operating room

Pain

Morphine is given in the usual dose if the patient is conscious and in pain Excessive morphine is harmful General anesthesia is dangerous and unnecessary

Shock

Shock should be anticipated if the burn involves more than 10 per cent of the body surface If shock is present, it is treated before local therapy is begun Do not rely on the blood pressure to determine the presence of shock It may be deceptively high, especially if the hematocrit (viscosity) is high Look for other signs of shock (See chapter on Hemorrhage and Traumatic Shock) If present, give plasma or whole blood rapidly, in whatever volume is required to correct the signs of circulatory failure In severe burns it may be assumed that the blood volume loss amounts to 40 per cent, so that not less than 2000 to 2500 cc of whole blood or plasma is required for replacement in an adult If the situation is urgent plasma may be started while blood typing and cross matching are being done Because the destruction of red cells is rapid in severe burns, at least half the transfusion should be whole blood

There is rapid and severe dehydration in burns because the burned area takes up and loses large amounts of extracellular fluid These patients should, therefore, receive large amounts of water and sodium in addition to blood and plasma The water and sodium may be supplied as salt solution or 1/ molar sodium lactate parenterally or by mouth if the patient can swallow and retain it Blood volume replacement is adequate if the urine output is continuously adequate

Local Therapy

Clothing is cut away and the patient is placed on sterile sheets Attendants wear caps, masks and sterile gloves Gross contamina

tion and detached fragments of skin may be removed by gentle rinsing with cotton balls soaked in warm soap solution This is not necessary, however *Scrubbing, opening blisters or debridement should not be done* The burned areas are covered with strips of sterile petrolatum or furacin gauze Do not use boric acid ointment because absorption of boric acid can occur The ointment gauze is covered with dry gauze pads, then with large pads or sterile machinist's waste and held with elastic bandages and adhesive Firm pressure is used for the extremities but on the face, head, neck and genitalia and on the chest and abdomen the dressing is not held so firmly Molded plaster splints may be used for extremities

Mineral oil in small amounts may be applied to burned nasal mucosa Do not allow the oil to enter the trachea Dextrose rinses and gargles may soothe the burned mouth and oropharynx Sterile mineral oil and local anesthetics may be instilled in burned eyes *Burns of the eyes* should be seen immediately and treated by the ophthalmologist

Severely damaged extremities may be prevented from exciting constitutional effects from infection or toxemia if packed in ice for some days The quantitative effects of trauma of an extensively burned patient can be temporarily reduced by isolating a large area by refrigeration Tissue viability will not be compromised Whatever severely damaged but still living tissue remains may be preserved

Chemotherapy

Local chemotherapy is not used All patients are given penicillin immediately (50,000 units intramuscularly) and at three to four hour intervals thereafter Because kidney damage from shock or hemoglobinuria is frequent in burned patients, sulfadiazine is not given until it is clear that renal function is good Tetanus antitoxin or toxoid is administered

Respiratory Tract Burns

Injury to the respiratory tract is suspected whenever there are burns about the nose and mouth or when the circumstances suggest the inhalation of hot or irritating vapors Swelling of the mucous membranes of larynx, trachea and bronchi plus the outpouring of large volumes of fluid may result in rapidly developing respiratory obstruction If obstruction is present epinephrine by nebulization, supplemented by aerosol penicillin oxygen or oxygen helium inhalations under positive pressure and tracheal aspiration (via catheter

or bronchoscope) may be needed A tracheotomy kit must always be present and tracheotomy should be done unhesitatingly for increasing obstruction, without waiting for evidence of visible anoxia Oxygen therapy and repeated tracheal aspiration will continue to be necessary after tracheotomy

The injured lung is susceptible to pulmonary edema, which may develop at once or several days after the burn, especially if saline solution is administered in large volume The burned lung is especially susceptible to infection, so that attendants must be masked Intratracheal aspirations must be carried out with a minimum of contamination and prophylactic chemotherapy should be vigorous

Initial Laboratory Studies

(1) Renal function is depressed Empty the bladder by a catheter and do a complete urine analysis, including *p*H Leave the catheter in the bladder and start an accurate hourly record of urine output (2) These patients become anemic very rapidly Do a red cell count, hemoglobin, smear and hematocrit (3) Infection of the burned areas is common Do a white cell count (4) Liver damage and large tissue losses occur Therefore, obtain blood nonprotein nitrogen, carbon dioxide, chloride, icteric index and plasma protein determinations (5) Determine the blood group and Rh type Multiple transfusions will be necessary (6) Observe for hemoglobinuria or hemoglobinemia These are signposts of an impending renal suppression

The laboratory data are repeated daily, if required, for ten days and then at least weekly thereafter Weigh the patient often, daily, if possible

Estimation of Size and Depth of Burn

The per cent of total body surface burned may be estimated by comparison with surface area diagrams * The extent of the burn correlates closely with the morbidity and mortality This is particularly true of third degree or full thickness burns, but full thickness burns cannot be definitely determined until after ten days or two weeks, i e , when the primary dressing is removed

SUBSEQUENT CARE

Observation and Nursing

Every severely burned patient requires special nursing In the first forty eight hours a half hourly record of pulse, blood pressure

* Lund and Browder Surg Gynec & Obst *79* 352 1944

and respirations and an hourly record of urine output is kept The temperature is taken every four hours unless it is above 105 degrees, when it is taken hourly An accurate fluid intake and output record is kept on a special sheet Pertinent remarks are recorded by the nurse as to appetite, tolerance of orally administered fluids and food, vomiting, diarrhea, sweating, respiration, cyanosis and the magnitude of wound drainage

Blood and Plasma

After the first day plasma therapy is not used Whole blood is given to sustain blood volume and red cell count Blood is continued daily until normal values are reached Blood is also used to correct a fall in plasma protein values below *optimal* normal values

Electrolyte Solutions

Oral therapy, when tolerated, is preferred to intravenous Offer every hour 200 cc of a solution composed of two parts of physiologic saline and one part M/7 sodium lactate or bicarbonate, flavored as desired Glucose may be added Up to four liters or more of this solution may be needed daily in the first forty eight hours, either orally or by vein, in addition to the blood or plasma given, unless there is pulmonary or renal damage Evidence of adequate fluid and electrolyte therapy in the first two days is a sustained urine output of some 30 to 60 cc per hour This may be expected to begin four to six hours after therapy has started If anuria or oliguria persist longer, renal damage must be suspected and fluid and electrolyte dosage reduced When it is not clear whether persisting oliguria is due to dehydration or to kidney failure, a test infusion of 1000 cc of 5 per cent glucose in water may be given rapidly If this increases the hourly rate of urine output abruptly, inadequate hydration is demonstrated, whereas a failure to respond suggests primary renal failure and requires care to avoid overhydration *In the presence of pulmonary burns or anuria due to renal failure edema must be avoided* by restricting the daily fluid supply to one liter (See section on Fluid and Electrolyte Therapy) If the patient has been untreated for a long period of time acidosis is likely This should be corrected by the electrolyte therapy just outlined If fluids must be restricted, use sodium bicarbonate or lactate solution without saline solution In the presence of hemoglobinemia, alkalinize the urine rapidly But excessive alkali therapy may result in alkalosis, especially when there is vomiting

After the first forty eight hours, the fluid and electrolyte requirements of a burned patient are much the same as those of other sur

gical patients Salt loss into the burned area may continue, so that 10 grams of sodium chloride a day should be given In the second and third weeks after a severe burn, reabsorption of the sodium and fluid deposits in the burned area may occur

Nutrition

Rapid and extensive weight loss, negative nitrogen balance and depletion of water soluble vitamins begin immediately after injury and persist as long as full thickness burns remain unhealed Hypo chromic anemia is common Sepsis markedly aggravates the mal nutrition and the anemia, which, in turn, retard wound healing Therefore, nutritional therapy must be vigorous Oral food adminis tration is greatly to be preferred The diet for an adult should con tain 4000 to 5000 calories per day and 300 to 400 grams of protein Supplementary water soluble vitamins should be given in four to five times the usual daily dose The diet is supplemented by trans fusions Careful attention paid to preparation of meals and manner of feeding can greatly increase the effectiveness of oral feeding If oral intake is inadequate, the diet may be supplemented or administered entirely by intermittent or continuous drip feedings through a Levin tube When feeding must be parenteral, 400 grams of glucose per day should be given slowly in 15 per cent solution as described in the chapter on Fluid and Electrolyte Balance Protein (whole blood, red cells in suspension, albumin, globin or gelatin fortified with amino acids) or amino acid solutions are given so as to meet the caloric and protein requirement as closely as possible Adequate feeding by the parenteral route, however, is difficult because sufficient protein in the form of blood or blood derivatives rarely can be given and be cause amino acids are not a source of protein synthesis unless the full caloric requirement is being supplied Elimination of sepsis and skin grafting, by interrupting tissue loss, play an important part in re storing nutritional balance Urinary nitrogen excretion in the later stages of severe burns may be reduced by testosterone propionate (25 mg intramuscularly every second day) This drug, if long contin ued, may produce hypercalcemia

Sedation

Frequent dressings produce pain and are usually unnecessary Substitute demerol for morphine Use small doses of barbiturate to allay apprehension and to reduce the amount of demerol or codeine required

Fever

Extreme hyperpyrexia may occur in the early period of severe burns Temperatures above 105° F require considerable increase in fluid administration and cooling by exposing the moistened skin surfaces to air currents from electric fans or by extensive ice packs

Dressings

The primary dressing is not changed for fourteen days Unsealed petrolatum strips on the face, genitalia and elsewhere are reapplied as necessary Major changes of dressings are done under aseptic con ditions in the operating room When the first dressing is removed, all burns other than those of third degree will have healed The extent of third degree burns can then be estimated Sterile petrolatum gauze is reapplied and covered by bulky dressings without pressure Dressings are changed at weekly intervals thereafter to evaluate the condition of the wounds and to do skin grafting These later dress ings may require general anesthesia, usually cyclopropane

Sepsis

Every deep burn is a devitalized and contaminated wound Sepsis is the greatest problem in burn therapy Sepsis and malnutrition are the cause of most late deaths from burns Contamination is mini mized by aseptic precautions at the primary and subsequent dress ings The most dangerous bacterial invaders are those from the nose, throat and hands of the surgical attendants Systemic chemotherapy is maintained until all full thickness burns are healed, although re sistant pathogens sooner or later predominate Cultures are taken at each change of dressings

Skin Grafting

Epithelialization eliminates susceptibility to infection, terminates negative nitrogen balance and permits functional recovery of joints, muscles and other tissues Spontaneous epithelialization of a full thickness burn of any extent will not be adequate and will be ac companied by extensive scarring, contracture and local loss of func tion It is slow, so that general debility is prolonged The new skin is thin, tight, inelastic, susceptible to fissures and ulcerations There fore, *split thickness grafts should be started as soon as any part of* the burned area is ready, i e, free of adherent slough and significant sepsis, although grafts will often take near areas of mild superficial sepsis Grafting may be done in two to six weeks from the time of the burn The value of local chemotherapy (penicillin, sulfonamides,

propamidine, tyrothricin, furacin, etc) and of medicaments for separation of slough (proteolytic enzymes, concentrated urea solution, azochloramid, pyruvic acid in starch paste) remains unsettled Immediate excision and grafting, i e, within the first twenty four hours, has been suggested for small full thickness burns with minimal systemic reaction,* because patients often continue to run a down hill course until the skin grafting can be accomplished Excision of slough in the second or third week for large full thickness burns, followed by early grafting, may eliminate chronic debility, but the considerable operating and anesthesia time and blood loss may produce shock The patient's general condition will determine the advisability of such therapy

* Cope O and Rheinlander, F W Annals of Surgery *117* 915 1943

CHAPTER 7

NEUROSURGICAL DISORDERS

BRAIN TUMORS

A prevailing belief in many quarters that intracranial tumors are, in general, hopeless diseases is in large degree denied by increasingly satisfactory results with respect to cure and still more with respect to prolonged relief Not only can the presence and location of the tumor be determined, but its probable nature predicted with some accuracy There is considerable disparity in the clinical behavior among the gliomas and between these and other tumors, even when they occupy the same area

Success in treatment often depends, not only on the nature and location of the lesion, but also on early diagnosis Persistent head ache, weakness or instability of an extremity not due to local causes, regional or generalized convulsive seizures, disturbances in vision, in function of cranial nerves, or changes in personality or in memory should lead at once to studies in the differential diagnosis of brain tumor

The Brain Tumor Suspect

Patients with a brain tumor may appear well, but may suddenly become acutely ill Study of these patients, therefore, must be car ried out as rapidly as possible yet without exhausting the patient The potentially disturbing procedures, such as spinal puncture should be left for the period immediately preceding surgery Enemas should be avoided if possible The history and physical examination should consider extracranial lesions as the source of the intracranial disorder (1) malignant disease (2) infection in the lung nose or sinuses leading to brain abscess, or (3) systemic diseases which may simulate brain tumor, i e , lead or hypertensive encephalopathy, uremia, etc Neurologic examination should include electro enceph alography, ophthalmoscopic examination, visual fields, x ray films of the chest and of the head and in sellar or parasellar lesions, blood

sugar, glucose tolerance curve, basal metabolic rate, follicle stimulating hormone and 17 ketosteroids assays

Specific Types of Brain Tumor

Gliomas constitute 40 per cent of all intracranial tumors Those occurring in the cerebrum frequently show a mixture of histologic types The *glioblastoma* is a highly malignant infiltrating tumor occurring only in the cerebrum of adults It often displays its presence so suddenly as to resemble a cerebral vascular accident, with coma supervening soon after a short period of headache or alteration of personality Destructive rather than irritative effects predominate, so that focal seizures are rare, cerebrospinal fluid pressure is not elevated markedly, and the disks are only slightly elevated There is no time for bone erosion to develop These tumors usually involve the frontal or parietal lobes and tend to be far more extensive than the neurologic manifestations indicate The outcome is unfavorable even after extensive lobectomy Reoperation for recurrence may prolong life for several years Removal of the bone flap at the time of the first craniotomy will delay the onset of the recurrent symptoms

The *medullary astrocytoma* behaves much like the glioblastoma It tends to be less infiltrative, it is more often cystic If it lies in the frontal or occipital lobe, it can be resected with a better prognosis than is the case for the glioblastoma

The *fibrillary astrocytoma* is most frequent in the third and fourth decades It grows slowly, and widely infiltrates the white matter If, as is usually the case, it involves a frontal lobe, there is pressure headache without localization, the disks are markedly elevated and may show hemorrhages, or there may be homolateral optic atrophy and contralateral papilledema (Foster Kennedy syndrome) Generalized seizures are common If the tumor lies in the temporal lobe, the "deja vu" phenomenon, dreamy states and partial or total hemiparesis may occur Jacksonian seizures may be diffuse or, if the tumor is in the right hemisphere, quite localized, e g , in the hand alone The skull films show pressure effects, erosion of the clinoids and occasionally calcification in the tumor

The *oligodendroglioma* grows even more slowly, often for several years before treatment is sought The location, the signs and symptoms are similar to those of the fibrillary astrocytoma The x ray film often shows a fibrillary network of calcification, as well as signs of pressure This tumor, as well as the fibrillary astrocytoma, tends to be cystic, thus simplifying its discovery at operation and its removal

Certain gliomas characteristically appear in one location or at a certain age

The *cerebellar astrocytoma,* commonest in the second and third decades, is almost always a cystic tumor in one of the lateral cerebellar lobes Its location causes ventricular obstruction early, with vomiting, headache, papilledema and reduced visual acuity Sometimes unexplained vomiting is the first evidence of the disease, and misdirected attention to the gastro intestinal tract results Homolateral ataxia, progressive involvement of the fifth, seventh and ninth cranial nerves of the same side, and finally dysmetric nystagmus are likely to develop X ray signs of pressure are reflected best in erosion of the clinoids, and the obstructive hydrocephalus may produce an enlarged sella turcica The tumor is a cyst containing yellow or brown fluid with a slowly growing noninvasive tumor nodule growing from the wall Total removal and permanent cure is the expected result of operation

The *medulloblastoma* is a rapidly growing tumor of the cerebellar vermis in young children and adolescents There is a striking, unsteady and broad based gait Paralysis of the abducens and papilledema are usual findings There is pain on percussion of the suboccipital region, the neck may be rigid and tilted in an effort to relieve pain The vision may fail rapidly Projectile vomiting and severe suboccipital headache, associated with high intracranial pressure develop early because the tumor blocks the roof of the fourth ventricle, so that emergency treatment is often required It is best treated by radiation therapy after biopsy and cerebellar decompression have been done The prognosis is often not good, because even radical extirpation is followed by recurrence from seeding of cells scattered during manipulation Prolonged improvement is often obtained by repeated x ray treatment

The *ependymoma* occurs in the spinal cord as well as in the cerebral hemispheres It is most common in the fourth ventricle, appearing at the cisterna magna, and extending downward into the spinal canal The commonest symptoms are headache and midline cerebellar symptoms The course is relatively rapid Complete removal is hazardous because of its proximity to vital centers A large decompression is made and postoperative radiation is given with considerable benefit

The *polar spongioblastomas* are inoperable tumors occurring frequently in the brain stem and other inaccessible areas The signs are generally of the "long tract" variety After their location is confirmed by operative exposure, decompression and x radiation may produce a worthwhile period of palliation

Meningiomas are benign tumors which press upon, but do not invade brain tissue Their size, position and vascularity may make their removal a formidable undertaking They occur closely attached to the dural venous sinuses A two stage operation is often required because of hemorrhage If not completely removed, they recur They require meticulous care postoperatively because edema, convulsions or shock may develop, owing to the fact that they are large and when removed result in considerable acute distortion of structures They are usually globular and well encapsulated, but a few are spread out (en plaque) Symptoms are slow to develop because they grow slowly The overlying bone may be eroded or thickened because of osteoblastic stimulation and invasion by the tumor The removal of involved bone, usually recognizable in x ray films, is often a hazardous undertaking because of its excessive vascularity Characteristic locations are parasagittal, i e , near the falx cerebri, or temporal, i e , in the Sylvian fissure, or along the lesser sphenoidal wing, olfactory groove or tuberculum sellae The tumors may be "silent" or their presence may be betrayed by the vascularity of the neighboring bone in the x ray film or they may produce characteristic localizing signs or symptoms, e g , anosmia in olfactory groove tumors

The *acoustic tumor* is nearly as common as the meningioma It is a neurofibroma of the eighth cranial nerve, causing unilateral deafness and vestibular disturbance, and by compression of the neighboring cranial nerves and brain stem produces anesthesia of the trigeminal nerve distribution, obstruction of the aqueduct, headache, choked disk and homolateral ataxia Complete surgical removal is curative, but facial paralysis may follow

Pituitary Tumors

(See section on Endocrine Disorders)

These constitute about 10 per cent of all intracranial tumors The chief neurologic evidence of their presence is a visual defect due to pressure on the optic chiasm which in turn causes a pull on the optic nerves which are injured by the pulsation of adjacent arteries or the rigid wall of the optic foramina The first disturbance is a defect in the upper quadrants of the visual field, and this progresses to bitemporal hemianopsia Eccentric unilateral expansion of the tumor may produce blindness in one eye or a homonymous hemianopsia Bilateral headache is common

The endocrine manifestations of pituitary tumors may precede the visual disturbances If vision is not affected and the tumor is

small, radiation therapy may be effective, although cystic tumors are relatively radioresistant If the defect in the visual field is large or getting rapidly worse, surgery is required to save vision If there is a reversible visual defect, the success of therapy, whether by surgery or radiation, can be gauged by serial visual fields

The surgical approach which gives the best exposure is a frontal craniotomy, but in case the field defect indicates congenitally short optic nerves, the transphenoidal approach is preferable Postoperative radiation therapy is often necessary, since total removal is unlikely

The *craniopharyngioma* is a cystic suprasellar tumor in children, arising in a congenital cell rest It produces bizarre visual fields and, by compressing the pituitary stalk and the pituitary gland, produces the Frohlich habitus and disturbances of water metabolism Total removal is rarely possible, but evacuation of the cyst gives temporary relief

The *pinealoma* causes ventricular obstruction early In addition to papilledema and headache, there is paralysis of upward gaze, which is pathognomonic The tumor is rarely resectable, but frequently responds well to radiation Side tracking the cerebrospinal fluid pathway may be necessary to make radiation safe

The favorite location of the *hemangioblastoma* is the cerebellum Occasionally the diagnosis is made preoperatively by finding a hemangioblastoma in the retina (Lindau's syndrome) This tumor is often completely removable

A spherical *colloid cyst* occurs in the third ventricle, and, by acting as a ball valve obstruction at the foramen of Munro, causes *episodic violent headaches of sudden onset Transient periods of* unconsciousness may accompany the headache or may occur simply on changing position of the head There may be no other symptoms The cyst is exposed and removed via the dilated lateral ventricle

MISCELLANEOUS BRAIN LESIONS

Brain abscess may be metastatic from the thorax, in which case it may be multiple, or it may be a direct extension of sepsis in the skull, characteristically the mastoid cells As in brain tumor, the signs and symptoms are related to the area involved though the course is more rapid Convulsive seizures are rare, and the systemic signs of infection are mild or absent

The objective in treatment is to delay radical surgery until the capsule of the abscess is firm This requires a minimum of three weeks

from the onset Meanwhile, chemotherapy is given, but it may be necessary to aspirate the abscess and then instill a smaller volume of antibiotic solution When the capsule is firm enough to make surgical handling safe, radical removal by lobectomy is done if the area involved warrants it If not, open drainage is performed When the capsule has shrunk, it extrudes itself or it is teased out The course of the process is followed by visualization of the cavity filled with radiopaque solution

Vascular anomalies are common and of several distinct varieties

1 *Arteriovenous aneurysm* between the internal carotid artery and the cavernous sinus (at the point where the former passes "through" the latter) causes pulsating unilateral exophthalmos, an extreme degree of chemosis, amblyopia and a prominent bruit The degree of exophthalmos and chemosis may require urgent surgery Ligation of the carotid artery in the neck often causes rapid recession of the eye, but the amblyopia may persist

2 *Arteriovenous angiomas* are congenital anomalous shunts, causing headache, convulsive seizures and increased intracranial pressure If a bruit is heard or a congenital vascular anomaly of the face or head is present, angioma may be suspected and so distinguished from brain tumor before operation They are likely to be unexpected findings at operation They may be identified by a preoperative arteriogram Carotid ligation is not successful because of widespread anastomoses Local ligations and resections are hazardous Decompression may be worthwhile

3 *Suprasellar aneurysm* causes pressure headache, monocular visual disturbance and oculomotor weakness The diagnosis can be made by an arteriogram or by x ray evidence of calcification in the aneurysmal wall

4 The "*Berry*" *aneurysm* is the commonest type of aneurysm and is often multiple It is a frequent cause of subarachnoid hemorrhage Resection is rarely possible Carotid ligation may be attempted in younger individuals, but the risk of postoperative hemiplegia is great

Chronic subdural hematoma is the result of injury, but a history of injury may be lacking The hematoma may have been present and silent for decades, only to become symptomatic after an increase in size by additional injury, or as a result of increase in its protein content and the consequent absorption of spinal fluid If the clot has been present since early childhood, the skull may show restricted growth and enlargement of air sinuses, secondary to suppression of brain growth

The symptoms vary widely, from personality changes or memory loss alone, to marked localizing signs, convulsive seizures, headache and visual disturbance Spinal fluid pressure may be normal or low The pineal gland may be shifted from the midline, and the electro encephalogram often shows depression of voltage at the site of the hematoma

The clot is frequently bilateral If a membrane is found, it may be necessary to turn a bone flap to achieve total removal Although the prognosis after removal is good, the brain may fail to expand after prolonged pressure and symptoms may persist

Tumors of the skull are likely to be cholesteatomas, which may reach large size without much distortion of skull contour Resection followed by cranioplasty is usually successful

Osteomyelitis of the skull may follow neglected compound fracture or suppurative sinusitis If resection of all diseased bone is followed by healing, the bony defect may be closed later by a tantalum or plastic plate

Hydrocephalus in very young children can occasionally be arrested by coagulation or resection of the choroid plexus Operation is indicated only if there is a substantial amount of spinal fluid absorption and if loss of cortical function is not excessive

Oxycephaly (scaphocephaly) a synostosis of some of the cranial sutures, retards brain growth in infancy Morcellation of the calvarium, the creation of artificial suture lines by the use of strips of polyethylene, or extensive multiple decompressions help in selected cases Early recognition is essential

Cranial meningocele is likely to be associated with cerebral defects, which, *if present, contraindicate operative repair*

Focal epilepsy resulting from cerebral scarring, secondary to cortical injury or to unknown causes, may not respond to anticonvulsant medication If the area involved can be identified by the electro encephalogram and by electrical stimulation of the exposed cortex, resection of the epileptogenic focus may cure the patient or make him more responsive to medication

PALLIATIVE NEUROSURGICAL PROCEDURES

Obstruction of the cerebrospinal fluid pathway or "benign stricture" of the aqueduct, may require construction of a new outflow by one of two methods (1) the Torkildsen operation, in which a rubber or plastic tube runs from a lateral ventricle through a posterior trephine under the scalp and thence into the cisterna magna,

or (2) the Stookey operation, in which the distended anterior end of the third ventricle above the chiasm is allowed to drain into the subarachnoid and subdural spaces

Subtemporal decompression may be needed as an emergency to relieve an otherwise intolerable degree of swelling The dura is opened widely through as large a bone defect as can be safely made through a muscle splitting incision or after reflecting (and later resuturing) the muscle from the temporal ridge A similar decompression is applicable to the posterior fossa

Orbital decompression for malignant exophthalmos removes the roof of the orbit to permit upward decompression of the orbital contents This may preserve what vision remains in an otherwise hopeless condition

Lobotomy at present should be regarded as a measure of last resort for certain severe neuroses or psychoses and for intractable pain The lobotomy must be bilateral to be effective, except when the procedure is done for relief of pain, when operation on the dominant hemisphere alone may be sufficient Operation is done either by the lateral "blind" approach (Moniz) or under direct vision from above

When the procedure is done for chronic, severe, agitated depression or intractable obsessive states, it is often successful and may even restore the patient to a useful place in society The operation may not abolish the patient's awareness of compulsive ideas, but if they persist, he feels no urge to act upon them Apparently the lobotomy results in the loss of the apprehension, suffering or anxiety that was formerly associated with the neurotic pattern Rehabilitation is far less likely in long standing schizophrenics, but it may greatly facilitate home or hospital management by removing suicidal or homicidal tendencies Temporary sequelae include fecal and urinary incontinence, confusion, mood or memory disturbances and transient neurologic disorders such as hemiplegia Permanent sequelae include loss of initiative and capacity for abstract thinking, great gain in weight and, occasionally, decline in intelligence An apathetic indifference, obstinacy and tactlessness in respect to social and family obligations may result Epileptiform seizures may be temporary or permanent, but they are controllable by dilantin Since there is a reorganization of the personality during the first three to six postoperative months, it is usually not possible to consider the procedure a failure until after such an interval The fact that a substantial change in the desirable as well as the undesirable qualities of the personality is produced makes the decision for or against lobotomy a difficult one and the source of considerable divergence of opinion among psychiatrists

Resection of cortical areas 9 and 10, selective electrocoagulation of the thalamus and supra orbital puncture are tentative alternatives to lobotomy, but they are still in the experimental stage

Lobotomy for pain may be preferable to cordotomy, for it carries less operative risk and the sequelae may be more tolerable than those following bilateral cordotomy It does not abolish the pain as does cordotomy, but it removes the apprehension, so that the patient is no longer disturbed by its presence

Operations for athetosis, tremors and similar disorders are still in the experimental stage The results of operations on the pre motor cortical area* related to the peripheral musculature involved are uncertain Better results follow if part of the adjacent motor strip is also removed,† but spasticity follows Resection of varying parts of the basal ganglia‡ and extrapyramidal tractotomy in the cervical cord§ are also being tried None of these operations has been wholly successful or without significant risk

HEAD INJURIES

Admission observations include the state of consciousness, blood pressure, temperature, pulse, respiration, external signs of injury, reflexes, gross neurologic signs These findings should be made and recorded by the same observer at intervals often enough to observe promptly any change in status, so that appropriate treatment may be instituted as soon as required

If the patient has been unconscious only for a few minutes or less and has no abnormal neurologic signs when examined, it is safe to say that he has had a concussion only If he has been unconscious for twenty minutes or more and/or shows abnormal neurologic signs or signs of increased intracranial pressure, there is a contusion laceration of the brain or intracranial hematoma or both

Scalp wounds should be carefully débrided after the patient is out of shock Before that do only enough to control active bleeding After careful cleansing and removal of damaged tissues, closure should be meticulous in all layers If brain pulp or bone spicules are seen, debridement becomes a major neurosurgical procedure In that case the wound is covered and must not be disturbed until operation is started

Bleeding from the ears, nose or mouth soon after injury sug gests compound basilar fracture The nasopharynx should then be

* Klemme R South M J *31* 1095 1938

† Bucy, P C Arch Neur Psych *37* 983 1937

‡ Meyers H R Trans Am Neurol Assoc *66* 176 1940 Browder J Am J Surg Vol 75 1948

§ Putnam T J Arch Neur Psych *39* 258 1938

inspected The patient should receive full dosage of sulfadiazine until long after bleeding has ceased Do not disturb an ear canal which is bleeding, since meningitis may result

Elevated intracranial pressure may produce no objective disturbance A rapid increase in intracranial pressure is indicated by a rising temperature, a rising blood pressure or pulse pressure, a slow or slowing pulse rate or respiration rate, increasing drowsiness or a depressed state of consciousness A mild degree of elevation of pressure, which persists, may be treated by parenteral hypertonic solutions An injection of 20 cc of serum albumin given intravenously slowly will lower pressure rapidly, but a subsequent rapid rise to as high or to a higher level results Slowly acting measures are preferable, unless the situation is urgent or immediate operation is to be done, in which case lumbar puncture or serum albumin may be used A slow method consists in the intravenous administration of 25 to 50 per cent sucrose in a dose of 25 to 50 grams for an adult It is given not more than twice daily and not oftener than on alternate days Another slow method is the use of a 50 per cent solution of magnesium sulfate, 15 cc orally or 30 cc rectally, every hour until diarrhea occurs Do not give it in ice water because it crystallizes out Not more than four doses may be used in any one day

Lumbar puncture is done only when specific information is required to determine the management of a patient who is not doing well It is not indicated in concussion It is contraindicated in compound fracture, whether in the base of the skull or calvarium If unconsciousness is prolonged, lumbar puncture may be necessary as a guide to treatment, but it should not be considered as a satisfactory or exclusive method of lowering the intracranial pressure In any case, do not perform the Queckenstedt test Record the initial pressure and remove *slowly* only as much fluid as is required for tests or in urgent cases for cautiously lowering a high pressure, i e , to half the initial level, but in no event below the normal level If the pressure rises again and continues high and neurologic signs persist, direct decompressive measures are needed

X-ray films are not necessary and should be avoided until the patient is ready to be out of bed or is to undergo surgery for clot removal or for debridement Linear fractures require no treatment

If there is no fever, fluids should be limited to 1500 to 1800 cc daily, most of it salt free Nutrition is a problem only in the unconscious patient In that case, utilize gavage with high protein fluids in small amounts frequently

Treatment of uncomplicated cerebral *concussion* requires rest only, for about a week, with a 15 degree elevation of the head to

promote venous drainage If there is headache, cold compresses or analgesics may be given If the patient is mildly restless or anxious, phenobarbital, 15 mg, may be given several times daily Extreme restlessness is a premonitory sign of rising pressure If the latter can be ruled out, sodium phenobarbital 60 mg subcutaneously every four hours or paraldehyde 6 to 8 cc every four to six hours may be given Avoid narcotics, including demerol

No attempt should be made to restrict the activity of children, except by confinement to bed The aged or debilitated should be allowed to sit up frequently

The indications for surgical intervention are as follows

1 *Depressed Fracture* This may sometimes be felt soon after injury, but after twelve hours the tissue reaction obscures the markings and an X ray film is required to demonstrate it A depressed fracture does not produce increased pressure unless local cerebral swelling or clot is associated with it The depressed bone should always be elevated when an x ray film shows spicules of bone derived from the inner table or if the fracture is compound In children the operation may be delayed for a week, unless the fracture is over a critical area Debridement for compound fracture is done as soon as the patient's condition permits

2 *Deterioration in the state of consciousness or progression of abnormal neurologic signs* should be considered possibly due to an intracranial hematoma If lumbar punctures show increasing pressure and if disturbances in vital signs are progressive, exploratory burr holes should be made over the middle temporal area the most frequent site of a subdural hematoma, unless the signs of injury or the x ray films indicate major involvement of another area

If the injury is major and operation is not required, symptomatic treatment is carried out Strict bed rest is imperative and fluids, nutrition mild sedation and chemotherapy are given as required As long as there are signs of continuing bleeding cerebral hypertension, fever or diminution of consciousness in any sphere, the patient is considered seriously ill and is kept on the danger list

If surgery has been performed the postoperative care is as for craniotomy

Headache and dizziness may persist long after recovery Psychotherapy may be required in patients with persisting symptoms

SPINAL INJURIES

Spinal column injuries are commonly overlooked The handling of patients having such injuries is so large a factor in the treatment

that the possibility of injury to the spinal cord ought to be considered in every patient who has had severe acute trauma, especially in those with back pain or any neurologic signs

Transportation of a patient with a spinal injury must be done with great care to avoid aggravating the basic injury He must be kept in hyperextension and never allowed to jack knife The compressed vertebral body tends thus to open out

If there is any involvement of the hands or arms, or if unconsciousness masks the picture, *cervical injury* may be present In that case *constant traction on the head must be maintained* This is done by a Sayre sling, by hand or by a loop wrapped around the assistant's waist, but best by a Zimmer collar with four turnbuckles, although this cannot be tolerated for very long Skeletal traction by tongs or wire traction should be applied as soon as possible X ray films are obtained early to determine the level and degree of vertebral injury Hyperextension must be maintained during roentgenography just as during transportation If the patient must be put on his back, he must have a blanket roll under the site of injury If lumbar puncture shows block and the neurologic status is deteriorating, decompression must be done at once, with skeletal traction applied If there is complete transection of the cord, decompression is useless

In lumbar or dorsal vertebral fracture with neurologic disturbance, the patient is turned on his side in hyperextension for spinal puncture, the point of entry must be below the fracture Dynamics are carefully measured The course of treatment depends on the presence and progression of dynamic block If such block is present and there is no area of total interruption of nerve impulses, laminectomy for decompression is immediately undertaken If block progresses between a first puncture and a later one after six hours, operation is indicated While considering the course of treatment, or if operation is not indicated, the patient should be constantly in hyperextension, which is best maintained by matched hyperextension shells

Dorsal and lumbar vertebral fractures need controlled position for four to six weeks Thereafter, if the patient's condition permits, he may be mobilized in a long rigid body brace or in a cuirasse

Bed care of the paraplegic patient, or of the patient with a less severely injured cord, taxes the ingenuity of doctors and nurses, but attention to simple details may make the difference between life and death

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Metastatic carcinoma causes root pain, often without clinical or x ray evidence of its presence

Extradural abscess is a rapidly advancing disease with marked toxemia, which develops as a complication of a chronic infection Osteomyelitis may be seen in x ray films It causes sensory disturbances at first, then a rapidly progressing paraplegia develops, with ileus and urinary retention If the lesion is at the twelfth thoracic to the first lumbar segments, incontinence may occur A dermatome of hyperesthesia may disclose the level before the condition spreads widely If the diagnosis and the level of the lesion can be determined, emergency drainage is mandatory because the function lost is likely to be permanent

The prognosis is better when the extradural abscess occurs at the level of the cauda equina There are signs of a lower motor neuron lesion If the diagnosis is suspected, spinal puncture is done with extreme caution, lest meningitis result

Cauda Equina Lesions

Neurofibroma may cause excruciating pain, which overshadows the meager or absent neurologic signs A striking degree of incontinence, with or without sensory disturbances in the perineum, suggests involvement of the conus, and if so, ependymoma is more likely

Painless tumors in this area usually show marked sensory, motor, reflex and vesical changes The motor and reflex signs are those of a lower motor neuron lesion The absence of pain may be due to fixation of the nerves in the capsule of tumor The sacrifice of a few such nerves for total removal is warranted, but if many are involved, intracapsular removal of the tumor contents followed by x ray therapy is preferable

Spina bifida warrants operation only in carefully selected circumstances In the infant, if the sac of an associated meningocele is thin walled, closure should be performed early to prevent ulceration, but operation is contraindicated if hydrocephalus, clubfoot, or any other major congenital malformation exists After infancy, exploration is warranted only if the neurological disturbances get worse Then repair of an occult meningocele, or liberation of nerves from fat, may prevent further damage

Syringomyelia may sometimes be retarded by connecting the cyst with the subarachnoid space and suturing its lining membrane to the arachnoid If the cysts are multilocular, the operation may fail and if the opening closes, it may be necessary to reopen it

SPINAL AND INTRASPINAL LESIONS

As a rule, the clinical picture of tumors of the spine or spinal cord does not identify the specific type of lesion present The level of the lesion can be determined with some precision In general, there is interference with function below the level of the lesion The earliest symptoms may be clumsiness or weakness of a leg, or subjective sensory disturbances, which later become objective Sooner or later the Brown Sequard syndrome appears A vague ache at the level of the lesion may be an early development, likely to be ignored as a signpost until a subsequent more overt expression of the tumor appears Spasticity of muscles is almost the rule, while atrophy is rare and, if present, may be explained erroneously as due to disuse In advanced lesions, a well demarcated sensory level is present

Neurofibroma is the commonest lesion It causes pain more frequently than other tumors, probably because its relative mobility permits it to exert root traction It is most prevalent in the low cervical and upper thoracic levels and at the conus It is readily removed, unless very vascular or anterior to the cord One or more nerve roots may have to be sacrificed Occasionally the tumor is a prolongation of a larger intrathoracic mass (dumb bell tumor), which must be reached by thoracotomy

Meningioma is almost as common It is most frequently found at the cervical and low thoracic levels The prognosis is good because it is usually placed dorsal or lateral to the cord and is avascular

Gliomas and astrocytomas are rare intrinsic tumors seldom removable *in toto* The cord may be split to allow extrusion of the tumor

Ependymomas grow slowly, proliferate along the central canal, and may be of considerable extent when exposed at operation Although occasionally the cord may be split and the tumor "peeled" out, the most delicate manipulations may be hazardous, because the remaining cord may be paper thin and its circulation may be further injured by removal of the tumor

While intrinsic tumors may be painless, discomfort at the site of the growth and referred pain to somatic or visceral dermatomes is common The Brown Sequard syndrome may not be present Sensory and motor disturbances may involve both sides The sacral segments may not show sensory loss until late

Vascular lesions may be arteriovenous angiomas, aneurysms or varicose veins Ligation or resection of isolated vessels may cause damage to the cord The prognosis is poor

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Ruptured Intervertebral Disk
(See Orthopedic Disorders)

Ruptured intervertebral disk produces root pain It is the most frequent cause of sciatica It may develop as a result of a single major injury to the back or as a result of frequent minor ones Root pain may be present from the beginning or not until after several episodes of back pain, each lasting several weeks or longer The muscles of the back may develop protective spasm, causing a list, and extreme pain may be elicited during examination by executing maneuvers which stretch the nerve The commonest locations of disk displacement are the fourth and fifth lumbar segments (L4 and L5) If the disturbance is at L4, the sciatic pain may be referred to the calf or into the great toe There may be weakness in dorsiflexion of the ankle and numbness over the instep If the disturbance is at L5, pain and numbness, if present, will be located near the outer malleolus and along the outer side of the foot

About a third of patients with a first severe attack will be free of discomfort after some four weeks Such a remission is not to be expected unless the pain disappears after ten days of rest Recurrences are likely and, if frequent and disabling conservative treatment should give way to surgical correction, which is curative in most instances

A myelogram should precede operation to demonstrate the exact location of the lesion In some cases this may not be necessary, but it is desirable to exclude multiple disk lesions

X ray films of the spine may be negative The spinal fluid protein is as a rule not abnormal

Disk removal is combined with fusion of the spine if (1) there is extreme mobility at operation, (2) there is osteo arthritis, or any congenital defect in the neighboring spine, or (3) the patient's occupation is physically arduous The prognosis is excellent

NEUROSURGICAL PROCEDURES FOR INTRACTABLE PAIN

Pain in malignant disease, which resists increasing doses of narcotics, responds well to intraspinal neurosurgical procedures

Subarachnoid alcohol block, using 1 cc or less of spore free absolute alcohol, usually relieves pain in the lowest lumbar and the sacral segments The alcohol should not be injected higher than the L3 interspace, because of the proximity of the conus Relief is long lasting, but is not permanent and bladder complications are common

Cordotomy, or section of the spinothalamic tract relieves contralateral pain at a level at least several dermatomes below the site

of cordotomy Touch perception is little affected, but bladder and motor disturbances are common If the dentate ligament is carefully observed in making the section, pyramidal tract disturbances are generally transient, but retention of urine is not avoided If both sides of the cord must be sectioned, the operation should be done in two stages, and the sections done at levels as widely separated as possible Since cordotomy must avoid the cervical enlargement of the cord and the phrenic outflow (from the third to the fourth cervical segments), the obliquity of the pain fiber crossing makes relief of pain in the arm or shoulder by cordotomy unlikely In that case, *medullary tractotomy* of the spinothalamic tract at the level of the posterior vagus fibers is preferable

Posterior rhizotomy may relieve pain confined to only a few cord segments It should not be done to relieve pain in an entire or even the greater part of an extremity, since it cuts off all sensation

If the rehabilitation of a paraplegic is retarded by spasticity in flexion, *anterior rhizotomy* of appropriate segments converts this condition into the flaccid state, making re education with braces possible

Lobotomy (See page 75)

DIAGNOSTIC PROCEDURES IN NEUROSURGERY

Spinal puncture should be done only if it offers the prospect of adding needed information The Queckenstedt maneuver should not be done if the lesion is at or above the foramen magnum It does not add needed information in intracranial disorders and it may be dangerous in elevated intracranial pressure, in head injuries and in vascular disturbances within the skull

X-ray films are required for adequate study in almost every case of neurosurgical disorder If an intracranial lesion is suspected, take chest films—for the lesion, whether neoplastic or infectious, may be metastatic Examine the skull films not only for signs of pressure (clinoidal erosion, pressure digitations on the inner table, enlargement of the sella turcica), but for localizing signs as well The pineal calcification should be carefully measured for displacement If it is toward the side of the lesion, the lesion may be a contracting rather than expanding type Abnormal vascularity of the skull may indicate a meningioma or a cortical vascular disturbance Localized hyperostosis indicates the presence of meningioma Intracranial calcification may indicate aneurysm, astrocytoma, oligodendroglioma or craniopharyngioma

In films of the spine, the site of suspected tumor may show an increase in the distance between the vertebral pedicles or a unilateral erosion of a pedicle In thoracic intraspinal tumors, examine the mediastinum for a mass A fusiform mediastinal shadow may indicate that the intraspinal lesion is tuberculous

Myelography is done to determine the exact location of a lesion Of the several opaque media used, Pantopaque is the most satisfactory It is not irritating, it shifts easily on tilting the x ray table, and its viscosity is such as to permit its complete removal by the spinal puncture needle at the end of the procedure (except in the presence of block, when the dye is rarely removable) If information is needed as to the location of the upper limit of a complete block, a second instillation of 0 5 cc can be made into the cisterna magna

Encephalography The replacement of spinal fluid by air, oxygen or helium serves to outline the subarachnoid space, and indicates displacement of cerebral structures, ventricular enlargement, cortical atrophy *It should not be done in the presence of elevated pressure,* or if the presumptive diagnosis is tumor, because of the danger of herniation of the brain stem Moreover, satisfactory ventricular filling, which is most essential in the diagnosis of tumor, will not be obtained

Pentothal is the best anesthetic for this procedure Room air is injected by the simple method, i e , through the single needle used for the spinal puncture The chances of better filling are no greater by the use of several needles It is not necessary to replace all fluid removed Appropriate positioning allows selective filling of different parts of the system so that from the several films a composite picture may be constructed

The headache and distress that follows encephalography can be markedly alleviated if the patient breathes 100 per cent oxygen, no matter what gas was used for the injection *

Ventriculography When tumor is suspected, and when the pressure is elevated for any reason, ventriculography is safer than encephalography The air can be released at a moment's notice A small amount of air may suffice if the intraventricular circulation is free Films are taken in various positions and the composite picture is as useful as that obtained by complete removal of the fluid The reaction is usually slight But serious developments occasionally result This possibility, plus the evidence obtained, require that the procedure should not be done unless the operator is prepared to do a craniotomy immediately thereafter

* Schwab R S Fine J and Mixter W J J.A M A *37* 1271 1937

The usual procedure is to inject the air into the atrium on each side posteriorly Frequently, better filling can be obtained by injecting air into the anterior horn with the patient prone

Arteriography may give information regarding vascular lesions which may not be disclosed by air injection films The distribution of the smaller vessels may indicate the nature of the tumor, especially a meningioma, or other excessively vascular lesions The carotid artery may be injected directly through the skin, but a better film can be obtained if the internal carotid is injected This requires surgical exposure of the vessel Meningiomas on the surface of the cerebrum receive much of their blood supply from the middle meningeal artery and may be better outlined by injecting the external carotid artery Thorotrast yields the densest shadows A total injection of 30 cc or less is quite safe Thirty five per cent Diodrast, which can be used in much larger amounts, often yields excellent outlines

Electro-encephalography should be used whenever possible While it frequently fails to give helpful information, it rarely misleads Its usefulness is diminished in the presence of increased pressure It has greatest usefulness when the patient is unresponsive It is valuable to distinguish between focal (e g , epilepsy) and diffuse involvement of the cortex It should not be relied upon as the sole *basis for localization before doing a craniotomy* Deeply situated lesions may, but are less likely to, show focal disturbances The nasopharyngeal lead has not yet been established as valuable

PREOPERATIVE PREPARATION

The scalp should be inspected and cleansed or otherwise treated, if necessary, well in advance of operation The hair should be clipped closely the day before surgery and the scalp shaven *by the intern or surgeon* immediately before surgery (not the night before) This is a severe emotional trauma, which can be minimized if done by the intern who has supervised the preoperative study and is best known to the patient Except in cases of trigeminal nerve root section, the entire scalp is shaven

All patients must be placed on the "Danger List" before going to the operating room and must have at least a liter of blood available If intracranial pressure is high, it may be necessary to operate as an emergency, especially if the state of consciousness is deteriorating, because decompression by dehydration or lumbar puncture may not be effective and may indeed be dangerous

Sedatives and narcotics are not to be used, except in minimal doses Sedatives are not to be used for epileptiform seizures unless "Dilantin" is ineffective

POSTOPERATIVE CARE OF NEUROSURGICAL PATIENTS

Until a patient's condition is stable, blood pressure and pulse are recorded every thirty minutes and after four to six hours every two hours If the temperature is fluctuating or exceeds 102° F, it is taken every hour for twenty four hours and longer after transfrontal (pituitary, etc) and intraventricular operations In other operations the temperature is taken every hour for four hours and then every four hours

The state of consciousness should be carefully observed, as it is the best indication immediately after operation of shifts in intracranial pressure If the patient appears to be asleep, the ease with which he is awakened is observed when the blood pressure is taken These observations should be made by the same person A special nurse is desirable for at least a day or two after any cranial operation Blood and fluid loss, which is frequently underestimated by 50 per cent, should be largely replaced during operation, but concealed intraventricular or deep intracerebral bleeding may occur afterward Oxygen should be administered by a Boothby mask Sips of water at room temperature are allowed post nauseam and the fluid intake thereafter is 1800 to 2000 cc daily for an adult, if the temperature is normal If not, add 100 cc for each degree of elevation Add twice as much if "cerebral hyperventilation" exists Administration of 1000 cc of saline intravenously daily provides adequate salt All additional fluids should be salt free to avoid cerebral edema

If a bone flap has been turned, pressure should be avoided in applying the dressing, as pressure is transmitted to the cerebrum Pad the ear well with cotton a "compressed" ear is painful Change the dressing daily for several days because a hard matted dressing hurts and is painful to remove Remove all superficial drains after twenty four hours and tie any untied sutures in the skin of the drain tract This does not apply to drains in an abscess or hematoma Cut forehead sutures on the first day, begin removal of sutures by the second day If primary healing occurs, all sutures should be out by the fourth day Otherwise, remove sutures as the local skin condition requires After the sutures are out the dressing need not be changed until the eighth to tenth day

In *suboccipital wounds* the scalp portion is treated as above and the neck sutures may be cut on the fourth day A cerebellar wound is

never drained unless there is an abscess It is wise, especially in children, to have an adhesive "halter" from brow to upper back, holding the head in hyperextension

Laminectomy wounds are treated like any trunk wound A scultetus gives comfort, but is not essential Interscapular laminectomy and cordotomy wounds are more likely to rupture than others, because of the pull of the shoulders The shoulders are held back with adhesive strapping applied obliquely

Cerebrospinal Fluid Fistula This may occur in a drain tract, but its likelihood is diminished if (1) the drain has been obliquely placed so as to come out through a stab wound, (2) if the drain is removed promptly and (3) if a skin suture closes the drain tract Slight additional pressure over the tract as it crosses the edge of the skull will help to obliterate it A suboccipital leak is seen not infrequently Treatment consists in bi daily lumbar puncture, limited fluids, elevation of the head, additional skin sutures, antibiotics

Hyperthermia may be fatal It is not infrequently seen after pituitary, parasellar, parahypothalamic and intraventricular operations Continued postoperative bleeding and excessive operative trauma may be the cause It is vital to control it early If the temperature reaches 102° F expose the extremities and apply cotton towels saturated with iced alcohol to exposed areas Change the towels frequently At 103° F pack the legs in ice, read the blood pressure frequently and give intravenous saline, if indicated Watch for a fall of temperature, which may indicate impending shock as a result of too drastic treatment If the patient is conscious and restless, give intravenous sodium phenobarbital *slowly* to depress the hypothalamus

The following signs indicate a rapid *increase in intracranial pressure* (1) rising temperature, blood pressure or pulse pressure, (2) slow or slowing pulse or respirations, and (3) increasing drowsiness

If in doubt, do a lumbar puncture to measure or to lower pressure Do *not* do the Queckenstedt maneuver If the pressure is elevated, lower it to half or to normal, whichever is reached first If it is still elevated, repeat the lumbar puncture in three to four hours Puncture is safer after a bone flap has been made, if the lesion is completely removed or, following cerebellar operations, if the edge of the foramen magnum and the atlas lamina have been removed and the dura opened to below the tonsillar level If pressure is not lowered by lumbar puncture and if drowsiness deepens and the initial postoperative neurologic defect increases, consider postoperative clot formation as a cause

CHAPTER 8

CRANIAL AND PERIPHERAL NERVE DISORDERS

THE CRANIAL NERVES

Tic douloureux is a disease of the *fifth cranial nerve* of unknown etiology. In nearly all cases no abnormality of this nerve in any part of its course has been found to account for the attacks, which consist of lightning-like stabs of pain in the distribution of the nerve. The pain is not commonly felt at night during sleep, but when awake the slightest stimulus to a trigger zone sets off paroxysms of excruciating explosive-like pains of short duration. The patient may apply strong pressure in a vain attempt at relief or may refuse to wash or clean the face for fear of exciting an attack. Trichlorethylene inhalations may help, but not for long, while morphine and scopolamine at best provide transient relief. Alcohol injection is of temporary value in people who cannot be operated upon. It may be tried as a method of confirming a doubtful diagnosis. Partial section of the posterior sensory root, with preservation of the ophthalmic fibers and the motor division, is nearly always curative. If the ophthalmic fibers must be divided, the resulting insensitive cornea may ulcerate if not carefully protected from dust or wind by the use of goggles, frequent moistening with sterile water and blinking. Permanent numbness always results and proves annoying to some patients. Damage to the superficial petrosal nerve during operation, with a resulting transient facial palsy, occurs very occasionally. Other transient postoperative annoyances are fullness in the ears, difficulty in opening the mouth widely and paresthesias. Because of these postoperative complications, division of the nerve in the medulla, which spares touch sensation, is now being done, with some prospect of having advantages over the classical procedure, but with the disadvantage that cerebellar ataxia may follow.

Division or alcohol injection of the supra-orbital nerve at its point of emergence from the skull is a useful procedure for intractable supra-orbital neuralgia, but it is not permanently curative.

Facial Paralysis

A gap in the *facial* (*seventh*) *nerve,* produced by surgical trauma during mastoidectomy, can be repaired by the use of a nerve graft, taken in advance from a small nerve such as the anterior femoral

cutaneous (Injury of the nerve in the canal before exit from the stylomastoid foramen can be determined by loss of taste in the anterior two-thirds of the tongue) Paralysis due to acute otitis media, or Bell's "refrigeration palsy," usually subsides spontaneously If function does not return after six weeks, and if there is no response to faradic stimulation, the swollen nerve can be released from compression by uncapping the facial canal and will often recover The result will not be satisfactory if the paralysis is of more than several months' duration Usually the need for this procedure arises in patients whose paralysis is associated in its early stages with regional pain If paralysis is due to chronic otitis media, the nerve in the facial canal is involved in an osteitis and should also be decompressed, but again only if there is no response to faradic stimulation Here, too, nerve repair will not restore function if the paralysis is of long standing and the muscles do not respond to galvanic stimulation When restoration of nerve function is impossible, even by a hypoglosso facial nerve suture, the angle of the mouth may be suspended to the temporal fascia by a fascia lata transplant While waiting to observe whether or not recovery will occur, the facial muscles should be exercised, massaged, stimulated by galvanic current and suspended, if need be, by an adhesive tape bridge from the angle of the mouth to the temporal area Such treatment is continued postoperatively until as full restoration of symmetry as can be hoped for is achieved

Meniere's Disease

The vestibular portion of the *eighth cranial nerve* may be severed intracranially for aural vertigo (Meniere's disease), a syndrome of unknown etiology, characterized by paroxysms of violent vertigo, nausea and vomiting associated with nerve deafness and tinnitus The operation is only done in severe cases which have not yielded to either of the following empirical, but frequently successful, methods of treatment (1) the Furstenberg regimen a salt free diet together with 3 0 or more grams of ammonium or potassium chloride, t i d , for three day periods with two day intervals without the drug (2) Horton's method 2 75 mg of histamine diphosphate in 250 cc of saline solution given intravenously at a rate of 50 to 60 drops per minute and repeated daily as needed

Glossopharyngeal Neuralgia

This disease is a counterpart of trigeminal neuralgia It consists of paroxysmal stabbing or shooting pain in the tonsillar fossa, posterior pharynx, base of the tongue or ear, initiated usually by swallowing

The tonsillar area is the commonest trigger point Relief by cocainization of the sensitive area verifies the diagnosis Intracranial division of the *glossopharyngeal (ninth cranial) nerve* relieves glossopharyngeal neuralgia without noticeable impairment of function Division of the nerve in the neck is ineffective because the most proximal branch leaves the nerve as it traverses the skull

Injury to the *spinal accessory (eleventh cranial) nerve* readily results from lack of due care to avoid this nerve during surgery in the midlateral region of the sternocleidomastoid muscle, where the external branch of this nerve is little more than subcutaneous This injury occurs during radical excision of tuberculous glands, or even as a result of simple incisions into pyogenic abscesses in cervical nodes Deliberate division followed by resuture is sometimes performed during radical neck dissections for malignant disease The injury results in partial weakness of the trapezius muscle, which is also innervated by the cervical nerves, with a resulting rotational displacement of the scapula and drooping of the shoulder

Branches of the *vagus nerve* (tenth cranial) may be put out of function by surgery or disease Injury to the superior laryngeal nerve during ligation of the vessels at the superior pole of thyroid may affect the pharyngeal constrictors Damage to the *inferior or recurrent laryngeal nerves* during thyroidectomy is a familiar phenomenon discussed elsewhere in this volume The left recurrent laryngeal is occasionally involved in neoplastic disease beneath the arch of the aorta, producing hoarseness Bilateral division of the vagus nerves, low in the chest, to suppress psychic secretion of gastric juice is proving to be a useful method of treating peptic ulcer The results of recent attempts to treat acute pancreatitis and acute ulcerative colitis by the same procedure in order to block the effects of psychic stimulation on the secretory functions of these structures remain *sub judice*

PERIPHERAL NERVE INJURIES

These occur as a result of direct trauma, chronic irritation or by involvement in a fracture If the wound is heavily contaminated, it may be wiser to delay repair until some weeks after the wound is healed In the case of a nerve involved at a fracture site, the injury may be due to contusion or overstretching of the nerve and later to compression by callus formation

The patient may complain of numbness somewhere in the area of innervation Vasomotor, secretory and trophic changes are most likely in injury to the median, ulnar and sciatic nerves The skin is

cold, dry and bluish and hypersensitive to cold Trophic ulcers (and cigarette burns) occur and growth of the nails is slowed The important thing is to recognize the nerve injury at the time it occurs Usually one single test, specific for a given nerve, will suffice for this purpose, providing disturbance in the function being tested is not attributable to other factors, such as direct trauma

It is not always possible to tell whether loss of function is due to anatomic or to physiologic interruption The latter is less likely to cause total loss of function Complete anatomic division results in complete paralysis and rapid atrophy of the involved muscles In addition, if pressure is applied to the nerve below the site of severance, there is no sensory response If there is doubt as to whether or not the nerve is severed, a decision can be reached by prompt exploration of the nerve, which should be done if time is not to be lost by futile waiting

The *dorsal scapular nerve* innervates the levator anguli scapulae, rhomboids and serratus posticus superior Elevation of the scapula is limited, but can still be performed by the trapezius when this nerve is out of function Pain over the scapular border and edge of the trapezius is due to fascial fibrositis

The *long thoracic nerve* innervates the serratus anticus, which keeps the vertebral border of the scapula firmly applied to the chest When one pushes forward with the arm, the scapula moves off the chest to produce a "winged scapula" if the power of this muscle is reduced by injury to this nerve

The *anterior thoracic nerves* innervate the pectoral muscles When the hand is placed against the flank on the same side, its power to push into the flank is lost and the pectoral muscles fail to contract if these nerves are injured

The *subscapular nerve* innervates the subscapularis, latissimus dorsi, teres major and serratus posticus inferior Adduction of the outstretched arm (latissimus dorsi) is weakened and extreme pronation of the hand (internal rotation function of subscapularis) cannot be executed if this nerve is injured

The *axillary nerve* innervates the deltoid and teres minor When this nerve is injured, the resulting atrophy of the deltoid causes loss of roundness of the shoulder, inability to abduct the arm and subluxation of the humerus

The *musculocutaneous nerve* innervates the biceps and brachialis anticus When this nerve is injured the forearm hangs limp, the deformity of the atrophied biceps is obvious, but supination can still be performed by the supinator longus

When the *median nerve* is injured, many of its motor functions in the hand can be taken over by other muscles The evidence of in jury depends on the level at which it is severed But in every case there is loss of sensation to pinprick in the radial half of the palm and volar surface of the index and middle fingers, atrophy of the thenar eminence, inability to flex the distal phalanx of the thumb and index finger or to touch the little finger with the thumb Cau salgia is a common accompaniment of this injury Neuritis of the nerve in the anterior carpal tunnel as a result of occupational trauma

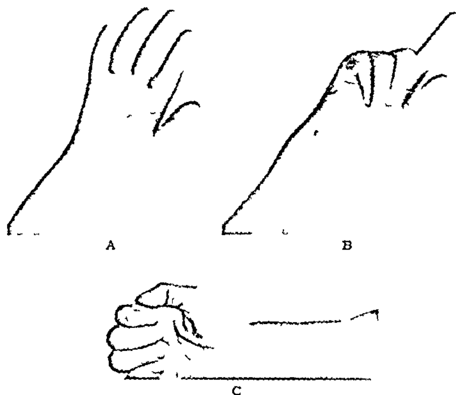


Fig 6 A and B Lesion of the median nerve The typical conical index finger whose flexion is limited or nonexistent. C Lesion of the median and ulnar nerves (Mercer Orthopaedic Surgery Wm Wood & Co Baltimore)

may require change of occupation or severance of the carpal liga ment to release constriction of the nerve

Damage to the *ulnar nerve* causes atrophy of the interossei, so that the spaces between the metacarpal bones deepen, the fourth and fifth fingers show flexion of the two distal phalanges adduction of the extended thumb cannot be performed and there is loss of pin prick sensation on the volar surface of the fifth and ulnar half of the ring finger A sheet of paper cannot be held firmly between the fingers of the outstretched hand Numbness paresthesia and motor weak ness may result from repeated trauma to the nerve in the groove at

the elbow, and transplantation of the nerve anterior to the groove may be necessary for relief

Injury to the *radial nerve* produces wrist drop, the distal phalanges, especially the thumb, cannot be extended and the grip is lost

The *femoral nerve* innervates the iliopsoas, quadriceps, sartorius and pectineus Injury to the fibers supplying the iliopsoas prevents flexion of the thigh, and in walking the forward swing of the thigh does not occur Climbing steps is therefore difficult If the quadriceps is involved, the lower leg cannot be extended on the thigh This is also most obvious in climbing stairs Crossing the legs while sitting is interfered with (sartorius)

The *lateral femoral cutaneous nerve* may be injured by prolonged flexion of the hip, with resulting numbness and paresthesias along the lateral aspect of the thigh and knee ("meralgia paresthetica") If the discomfort persists for six weeks or longer, division of the nerve or release from the iliac fossa may be indicated

The *obturator nerve* supplies the adductors of the thigh If it is damaged, the legs cannot be crossed Irritation of the nerve in the obturator foramen causes pain in the knee

When the *sciatic nerve* is injured, the calf is atrophied The knee cannot be flexed when walking If only the *external popliteal* (peroneal) is affected, and this is much more common, plantar flexion (equinovarus), causing a steppage gait, results Transient paralysis lasting only a few weeks can be produced by prolonged pressure upon the nerve when the patient has been sitting with the knees crossed for some hours If the *tibial nerve* is injured, plantar flexion cannot be performed, the heel cannot be raised when the weight is carried forward on the foot in walking Pes calcaneus or pes cavus may result Causalgia occurs in this injury

Not all sciatic pain is due to a prolapsed disk Root pain from a disk is referred all the way from the spine caudally Sciatic neuritis seldom causes pain proximal to the great trochanter, is associated with tenderness along the course of the nerve in the thigh, and there is no limitation of motion of the hip or spine

Injury to the *superior gluteal nerve* paralyzes the internal rotators of the thigh, so that in the supine position external rotation is pronounced On standing the anal crease is distorted

Rarely the *inferior gluteal,* which supplies the gluteus maximus, may be injured The trunk then cannot be extended on the thigh This disability is obvious on climbing stairs or on getting up from the sitting position

CHAPTER 9

SYMPATHETIC NERVOUS SYSTEM

Conditions amenable to sympathectomy include Raynaud's disease, thromboangiitis obliterans, the vasospastic sequelae of frost bite, immersion foot or trench foot, angina pectoris, hypertension, hyper hidrosis, causalgia, amputation stump neuralgias, erythromelalgia, selected instances of megacolon and chronic intractable ulcerations of the extremities associated with vasospasm Ischemia due to major arterial injury may be improved by sympathectomy to relieve as sociated reflex vasospasm in collateral vessels

Since the upper *abdominal visceral pain* pathways are mediated through the sympathetic nervous system, relief of pain by sympa thectomy may be indicated in the absence of a demonstrable pathologic condition or when the disease responsible for the pain is inoperable (e g , pancreatic lithiasis) or when other measures have failed If sympathetctomy is done, especially bilaterally, the warning signal of pain from a visceral lesion which may develop subsequently, such as perforated ulcer, will not be present The peritoneum and abdominal wall are not deprived of sensory innervation by this procedure

Selected cases of intractable *status anginosus* can be alleviated considerably either by alcohol injection of the upper four left thoracic sympathetic ganglia, or if the risk is warranted, by surgical extirpa tion of this segment of the sympathetic chain

An effective sympathetic denervation must be preganglionic, since regeneration will occur if the resection is postganglionic Permanent effective denervation of the upper extremities, as for Raynaud's disease, requires preganglionic dorsal sympathectomy by spinal root section of the second and third intercostal nerves and division of the sympathetic chain below the third ganglion The second and inter vening trunk are not removed because epinephrine sensitivity is increased as a result *

* Recent follow up studies indicate that even preganglionic sympathectomy may not be permanent Some cases of return of vasoconstriction and sweating after lumbar sym pathectomy have been observed Evidently prevention of regeneration of sympathetic fibers requires more care than has heretofore been considered necessary The presence of epinephrine hypersensitivity was formerly considered evidence of postganglionic rather than preganglionic sympathectomy Even when this phenomenon can be observed it is transient i e it does not persist for more than a few months postoperatively It there fore is not a reliable test Haxton H A British Journal of Surgery *35* 69 1947

The lower extremities are usually adequately denervated by removal of the second and third lumbar ganglia. This procedure constitutes a preganglionic neurectomy *for the lower extremities* Occasionally, in order to improve blood flow in the thigh, resection of the first ganglion may be desirable. This is quite difficult when utilizing the usual flank or abdominal incision, inasmuch as the fascial portion of the right crus of the diaphragm frequently obscures this ganglion

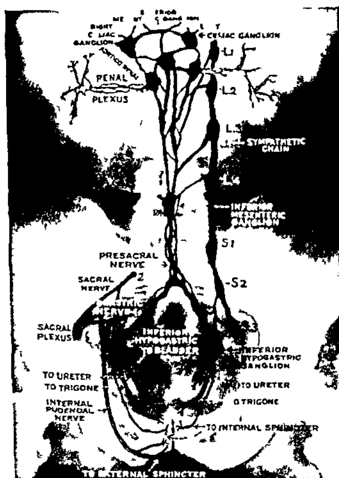


Fig 7 Relationship of lumbar sympathetic nerve trunks to skeletal and other structures (By courtesy of Dr M Leopold Brodny)

Removal of both the first and second lumbar ganglia bilaterally in males usually, but not always, results in failure of ejaculatory power, but libido and potency, which are controlled by parasympathetic nerves, are retained. Occasionally, due to the marked variability of sympathetic supply, the power of ejaculation may not be lost even after extensive bilateral lumbar sympathectomy

Conservative therapy of vasospastic disorders should be tried before resorting to sympathectomy. This therapy consists largely in

blocking sympathetic outflow Occasionally the injection of procaine once or several times into the appropriate sympathetic ganglia may break a reflex vasospasm which threatens viability, as in vasospasm complicating embolic occlusion of a large peripheral artery, or in deep thrombophlebitis of the lower extremities Rarely the same procedure may produce long standing relief in chronic disorders complicated by vasospasm More commonly this procedure serves only as a means of diagnosing the degree of vasospasm and assessing the value of a subsequent sympathectomy

The effectiveness of the block produced by procaine can be judged by the absence of perspiration in the denervated area The starch iodine color test may be used for this purpose If a dry skin results, the rise in surface temperature of the distal part of the involved area will be a measure of the degree of vasospasm This rise should be at least 3° or 4° C unless the blood flow is reduced by organic occlusion The rise in Raynaud's disease may be much greater because the extremities in this disease are at the temperature of the environment

Vasoconstrictor fibers may be blocked by spinal anesthesia, which interrupts them in the anterior roots, by direct injection of peripheral nerves, or preferably by procaine infiltration of sympathetic trunks and ganglia *These fibers to the upper extremity* run from the eighth to the second thoracic spinal segments through the corresponding part of the thoracic sympathetic trunk, whence they reach the second and first (stellate) thoracic and inferior cervical ganglia *Block of these ganglia* is done by injecting 5 cc of 2 per cent procaine through a needle which is inserted just above the inner third of the clavicle, whence it passes upward, inward and backward until it strikes the body of the first thoracic vertebra Within fifteen to thirty minutes Horner s syndrome, dryness and a rise in temperature of the arm, face and head of that side should be evident

Lumbar Block

(See Peripheral Vascular Disease)

Pharmacologic therapy of diseases involving the autonomic nervous system is based on the following facts (1) Both parasympathetic and sympathetic preganglionic fibers liberate acetylcholine at their distal synapses (2) parasympathetic postganglionic fibers liberate acetylcholine (motor nerves to muscles do likewise), (3) the postganglionic fibers of the sympathetic system liberate sympathin, which functions much the same as epinephrine *Tetraethyl ammonium salts,* recently introduced for the relief of vasospasm, are therapeutically disappointing because they act by blocking all the

ganglia of both systems, producing general rather than selective vasodilatation, and postural hypotension They inhibit micturition and motor function of the gut, and their effect is short lived *Dibenzylbetachloroethyl amine* ("dibenamine") and the benzylimidazolines ("priscol") act more selectively by blocking only adrenergic fibers and their effect is much more prolonged These drugs, however, have side effects which may eventually contraindicate their use, but they deserve more exploitation

ESSENTIAL HYPERTENSION

Specific renal, endocrine or cerebral disorders may produce chronic hypertension, but most cases show no primary extravascular disease In essential hypertension the systolic and diastolic pressures are elevated and the pulse pressure is increased There is increased blood volume Blood flow through tissues is normal These patients react excessively to emotional and other stimuli and vasomotor tone in arteries and veins is increased, but the peripheral resistance is not fixed Eventually the heart, brain or kidneys become deficient and failure of one of these systems causes death

The Heart

Cardiac output is normal in essential hypertension, but the work of the heart is much increased and this produces hypertrophy The hypertension also accelerates the aging process in the vessels, so that premature coronary disease may result Venous hemodynamics are not altered and the right ventricle is not involved Only the left ventricle is under stress The characteristic electrocardiogram changes (inversion of the T wave, depression of ST segment in leads I and II and left axis deviation) are not related to the severity or duration of the hypertension, but are a result of pressure stress They disappear when sympathectomy restores a normotensive state The fall in blood pressure and the changes in the electrocardiogram after sympathectomy do not necessarily signify a better prognosis, although there is evidence that coronary flow may be improved The opposite, however, may result in patients with coronary arteriosclerosis, because of the shift of blood to the lower extremities and the hypotension

The Central Nervous System

Fifteen per cent of hypertensive persons die of cerebral hemorrhage or thrombosis due to arteriosclerosis of large arteries In contrast to

the relatively minor degree of arteriolar sclerosis in the heart, the arterioles of the central nervous system show considerable degeneration In spite of the hypertension, the oxygen consumption of the brain is slightly below normal, probably because of increased resistance due to organic narrowing of vessels as well as vasoconstriction

The vascular lesions result in clinical manifestations such as headaches, sensory and motor disturbances of varying degree, with coma or convulsions in the "malignant" form or intellectual and personality changes in the slowly progressive forms Retinal edema or hemorrhage, vasoconstriction of the vessels in the fundus, etc, reflect similar changes in the brain The prognosis in the presence of retinal hemorrhages is always bad Temporary asphasia or blindness indicates focal lesions in the brain

The mechanism of headache, which is so common and often incapacitating, is not well understood It may behave like migraine, i e it may be due to stretching of arterial walls The headache is suboccipital, is felt most severely before rising in the morning and is relieved as activity of the day progresses, perhaps because less blood reaches the brain in the erect posture

The common symptoms of excessive sweating flushing, whealing and other evidences of vasomotor instability signify a definite involvement of the autonomic system, which may be "set" at a higher level of activity by the hypertension

The Kidney

The renal vasculature is highly reactive to emotion, pain exercise, blood loss and change in posture Most hypertensive patients show renal arteriolar constriction and renal ischemia, but whether the hypertension precedes or follows these changes is not yet certain The renal flow as measured by diodrast clearance values is slightly reduced in hypertension, but the marked increase in flow in response to pyrogens demonstrates that the reduced flow is due to vasoconstriction rather than organic vascular occlusion

In 85 per cent of patients the vasculature is not seriously affected and renal function remains satisfactory Glomerular filtration remains normal in spite of reduced plasma flow because the vasoconstriction affects the efferent rather than the afferent arteriole The total renal blood flow is not increased by spinal anesthesia or sympathectomy This suggests that the vasoconstriction is produced by a humoral or local reflex mechanism rather than through nerve pathways

Recently, a diversion of blood flow from the renal cortex to the medulla by an overactive sympathetic nervous system has been demonstrated in animals (Truetta) * Thus a relative ischemia of the cortex with a resulting production of pressor substances by the con voluted tubules may occur in the absence of organic renal disease It is, therefore, possible that hypertension may be due to effects upon cortical flow without altering total flow and that splanchnicectomy or sympathectomy may redistribute flow and eliminate or alleviate hypertension by restoring normal blood flow to the renal cortex

Hypertensive individuals show an altered tubular disposal of sodium and chloride, possibly because of an adrenal cortical dis turbance, although the evidence for this is lacking A restricted salt intake may alleviate the hypertension, but this is not proved

The general increase in vasoconstriction is less intense than in the kidney and brain, which, together with the heart, suffer more damage to the vessels than other organs It is evident that neural, humoral, reflex and cortical factors all play roles, but their relative importance has not yet been established

Sympathectomy

The therapeutic gains of sympathectomy are thought by many to be due wholly to reduced systolic and diastolic pressure That this is not the case, however, is clear from the fact that general well being, relief from headache and disappearance of retinopathy frequently occur without a fall in blood pressure

Another explanation for the benefits of sympathectomy is the general redistribution of blood flow so that less blood reaches the brain and heart, because more is diverted to the denervated area—witness the cold hands and warm feet of the patient after sympathec tomy

The criteria for the selection of suitable candidates for sympathectomy vary widely, depending on the viewpoint as to the prognosis of the given case with or without surgery According to one view, patients who may be expected to benefit from sympathectomy are those who show a significant depression of elevated tension under heavy sedation and who do not show advanced vascular sclerosis The validity of this test is in doubt, since the postoperative result frequently does not square with the results of the test Another view is that the great majority of patients can be adequately treated con servatively, and that only those with a malignant hypertensive

* Truetta J et al Studies of the Renal Circulation Charles C Thomas Company Springfield Illinois 1948

condition should be operated upon Some protagonists of this view state that only those patients with a persistently high diastolic pressure prove resistant to treatment with sulfocyanate and that sympathectomy should be reserved for such patients If a good result does not follow, the patient will then become sensitive to sulfocyanate, under which he will be able to function socially and economically For patients with a labile diastolic pressure the results with sulfocyanate alone will be as good as from sympathectomy

Most observers agree that if careful and well controlled medical therapy is not satisfactory and if the symptoms are sufficiently troublesome, sympathectomy may be indicated, providing the definite contraindications to sympathectomy are not overlooked These are (1) severe renal damage, inability to concentrate the urine above a specific gravity of 1 019 or a blood nonprotein nitrogen above 40 mg per 100 cc , (2) congestive failure resistant to treatment, auricular fibrillation or heart block, and coronary arteriosclerosis, (3) cerebral arteriosclerosis, as manifested by depression, mental deterioration or repeated vascular accidents, (4) diastolic pressure averaging less than 110 mm of mercury or consistently below 130 mm of mercury (these patients have at least five or ten or more years of useful life and do not require the operation), (5) patients over fifty five years of age, i e , those with definite arteriosclerosis Symptoms due to the latter will not be helped and may be made worse

Probably not more than one in twenty to twenty five patients with essential hypertension is a suitable candidate for sympathectomy A substantial number of properly selected patients, however, will be improved and economically rehabilitated The benefits which may be expected from sympathectomy in properly selected subjects are (1) Both systolic and diastolic pressure will show an average permanent fall about 15 per cent below the preoperative level The fall may be much greater in the first few weeks or months postoperatively, but the blood pressure tends to rise thereafter A judgment on the effectiveness of sympathectomy made solely on the basis of the fall in systolic and diastolic pressures is not valid unless the true basal pressures have been determined by prolonged observation prior to operation under conditions free of psychic excitation (2) General symptomatic improvement occurs in about 60 per cent of patients operated upon Headache is relieved in 85 per cent, whether blood pressure falls or not Restlessness, pounding in the head and dizziness frequently disappear Even convulsions may be dissipated (3) Patients with retinopathy die within eight to twelve months

without operation Most patients with retinopathy are completely relieved and their lives are prolonged by sympathectomy

The operation, however, is not a cure, because evidence of essential hypertension persists indefinitely, however modified in clinical expression Reduced blood flow to brain and heart may aggravate disturbances in these organs due to arteriosclerotic disease Narrowing of coronary and retinal vessels is not influenced by the operation A good early response to operation is by no means always a sustained one Long term follow up observations reveal an increasing number of failures But end results have yet to be fully evaluated

There is considerable and prolonged postoperative discomfort many months of orthostatic hypotension requiring elastic compression of the abdomen and legs, cold hands, occasionally neuritic pains in the region of the incision, the loss of the power of ejaculation and, therefore, of fertility Nevertheless, the operation in suitable cases has a legitimate place if it can achieve substantial symptomatic relief for a long time, even though it does not cure the disease

Current operations for the relief of essential hypertension remove all or part of sympathetic chain from the fourth dorsal to the third lumbar ganglion on both sides, in two stages All procedures in vogue also include the three splanchnic nerves

The preoperative study should include the following special studies electrocardiogram, seven foot heart plate, circulation time, vital capacity, and determination of the renal status by several urinalyses, concentration test, intravenous phenolsulfonphthalein test, intravenous pyelography and blood nonprotein nitrogen A detailed study of the eyegrounds with the pupils dilated, careful neurological examination and evaluation of mental status are also pertinent

The stability or lability of the blood pressure level is determined as follows

(1) The basal pulse and blood pressure are observed and the blood pressure recorded every four hours The effect of sedation is determined by the following tests, which are done by a special nurse in order to eliminate the pressor effect of a physician's presence After a light supper the patient is given 0 2 gram of sodium amytal orally at 7 00 P M , 8 00 P M and 9 00 P M The pulse and blood pressure are recorded every fifteen minutes for the first three hours, then every hour for the subsequent nine hours until 7 00 A M , noting whether the patient is asleep, drowsy or awake at each reading

(2) Postural and pressor test The room should be quiet, the patient lying comfortably at rest for fifteen minutes The pressure is

then taken every minute for five minutes in the lying, sitting and standing positions and finally again in the lying position The hand opposite the side on which the blood pressure is being taken is then placed in ice water up to the wrist for exactly one minute, the pulse and blood pressure are taken after thirty seconds and again after sixty seconds and then every minute for five minutes and for five minutes more in the standing position

Postoperative Care Penicillin is administered for three days After bilateral sympathectomy a constant infusion of glucose in water at 60 to 75 drops a minute should be maintained for the first twenty four hours Oxygen is given if cyanosis is present Occasionally, a troublesome form of girdle neuritis becomes manifest about a week after operation due to pressure on the twelfth intercostal nerve during the operation

No alterations in blood pressure occur after unilateral sympathectomy Hypotension occurs after the second stage It is counteracted by elevating the foot of the bed and applying a snug abdominal binder Neosynephrin, 0 3 cc subcutaneously, may be administered every fifteen minutes p r n If three doses are necessary, blood or plasma is given Elastic leg bandages (toe to thighs) are put on before getting the patient out of bed, since gravity aggravates the hypotension When the patient is up he must be urged to keep moving, to walk slowly, never to stand still Gradually an adjustment and stabilization of the blood pressure is effected, but in some cases severe postural hypotension may last for months

Before discharge from the hospital the following studies should be repeated Electrocardiogram, intravenous phenolsulfonphthalein test, urine analysis, blood nonprotein nitrogen seven foot heart plate and the cold and postural tests in the horizontal position only (without bandages)

CAROTID SINUS SYNDROME

A nerve plexus connecting the bifurcation of the common carotid to the vagus and sympathetic trunks in the neck functions as a vasodepressor mechanism by producing vasodilatation when the blood pressure in the carotid artery rises The resulting drop in blood pressure is about 10 mm in the normal subject But occasionally victims of an exaggerated sensitivity of the sinus show three types of reaction which can be reproduced by pressure over the sinus, (1) transient asystole or bradycardia with or without fall in blood pressure, (2) fall in blood pressure without slowing of the pulse rate,

(3) syncope or convulsions without blood pressure or pulse changes Heart block, temporary asystole or extrasystoles, and electrocardio graphic changes also occur These latter effects are mediated through the vagus nerve and can be blocked by atropine The other responses are mediated by other pathways and can be blocked only by the injection of novocain (producing a Horner's syndrome and recurrent nerve paralysis) as a test for diagnostic purposes Periarterial sym pathectomy of the sinus involved is often curative Quinidine may be used to inhibit vagus effects upon the heart, but its effect in abolishing attacks is not striking

Carotid body tumors may or may not produce the syndrome, depending on whether or not they irritate the sinus

CHAPTER 10

DENTAL DISORDERS

Routine preoperative preparation for dental or oral surgery is the same as for general surgical patients

Routine postoperative care includes (1) an ice pack to the involved jaw for twenty minutes of each hour, (2) hot irrigations every two hours and chemotherapy as required

Toothache may be due to

Acute Pulpitis

This is suspected if there is a tooth with a cavity, a large restoration, a fracture or a deep periodontal pocket There may be localized tenderness, but there is no swelling and the tooth is not loose An x ray film should be taken to substantiate these findings

It is not always possible to localize the pain to any particular tooth for hours to days The pain is more severe when lying down Pain in the upper jaw may be referred from a tooth in the lower jaw or vice versa If the actual source of pain cannot be ascertained at once, watchful waiting is indicated and sedation resorted to

Treatment If a cavity is present or the pulp chamber is accessible, immediate though temporary relief will result from removal of debris from the cavity and the insertion of a small pledget of cotton dipped in 2 per cent pontocaine, 5 per cent cocaine butyn or nupercaine For more lasting relief follow with the insertion of a pledget of cotton dipped in oil of cloves and seal with gutta percha Further treatment requires a dental specialist

Acute Periodontitis (Pericementitis)

There is a tooth with a cavity a large restoration, a fracture or a deep periodontal pocket The buccal or lingual mucosa and the tooth itself are tender The tooth appears elongated and it is loose Percussion is extremely painful and the x ray film shows a widened periodontal space

Treatment For immediate relief keep the teeth apart to rest the involved tooth Sedatives or narcotics are given as indicated For more lasting relief consult a dental specialist

Dento alveolar Abscess

The pain is continuous, severe and throbbing There is swelling of the involved jaw, the face is flushed, the mucosa around the involved tooth is red, swollen, tender and fluctuant The tooth appears elon gated and is tender to touch Percussion is very painful Pain is re lieved by cold water in the mouth and increased by hot water The x ray film shows a widened periodontal space and beginning apical rarefaction

The regional nodes may be swollen An x ray film may reveal no bone disease other than an increase in width of the periodontal space or apical rarefaction

Treatment Some immediate relief in early cases is obtained by an ice bag to the jaw on and off every fifteen minutes If the condition is well developed, penicillin or sulfonamides are given If external pointing is evident, hot packs are applied If intra oral pointing is evident, hot saline irrigations are given hourly If fluctuation is present, incision and drainage with or without extraction of the tooth is indicated

Cellulitis of the Floor of the Mouth (of dental origin)

Unilateral submaxillary cellulitis produces severe, continuous pain, partial dysphagia and fever There is swelling under the jaw and chin The floor of the mouth is raised on the involved side, limited by the median raphe There is partial trismus and difficulty in moving the tongue The submandibular and cervical lymph nodes may be swollen The treatment is the same as for dento alveolar abscess

If the process is bilateral, the floor of the mouth is raised above the occlusal surfaces of the teeth, the teeth and gingiva are covered with sordes, the tongue is pushed up against the palate, the lips and gingiva are dry

Treatment Have a tracheotomy kit ready (See chapter on Oto rhinolaryngology) Give chemotherapy in large doses Keep the pa tient sitting up If there is cyanosis or respiratory embarrassment there is edema of the glottis If chemotherapy is not effective within a reasonable length of time, tracheotomy may be required as an ur gent and life saving measure The evacuation of pus is best achieved through an incision below and parallel to the inferior margin of the mandible into the deep space of the floor of the mouth

Acute Osteomyelitis of the Mandible

There is severe, throbbing continuous pain, fever, partial trismus and diffuse swelling The teeth in the involved area are loose, appear

elongated and are tender to touch The submandibular glands are palpable X ray films early in the condition are negative, but after forty eight hours the periodontal spaces of the teeth on the involved side may be widened Later the bone appears moth eaten and sequestrum formation is evident

Treat as for osteomyelitis elsewhere

Fracture of the Jaw

There is pain on motion, swelling, malocclusion, trismus, bleeding from the mouth and laceration of the oral mucosa There is mobility of the fractured segments and the teeth in the neighborhood are loose or subluxated Take x ray films

If the maxilla is fractured, there is severe pain on occlusion The maxilla is swollen There may be bleeding from the nose, the maxillary oral mucosa may be lacerated and the fracture fragments may be felt through the mucosa The teeth may be loose, fractured or subluxated and are tender in the line of fracture

Treatment Place teeth in as near normal occlusion as possible, put on a Barton, Gibson or four tail bandage and arrange for a wire splint by an oral surgeon

Dislocation of the mandible causes inability to close the mouth The condyles can be felt in an abnormal position and the mouth is wide open Use light anesthesia, cover your thumbs with a towel or gauze, stand in front of the patient, place the thumbs over the lower posterior teeth and the fingers under the jaw and push the mandible downward and backward, then upward and forward The condyles will slip into place Put on a Barton bandage for twenty four hours

Hemorrhage from a tooth socket or from the lingual or buccal mucosa can be stopped by pressure, suture, gel foam or infiltration of 2 per cent novocain with 1 50,000 epinephrine A suture through the mucosa distal to a bleeding socket may stop hemorrhage If not, consult a dental surgeon

CHAPTER II

SURGERY OF THE MOUTH AND NECK

The mouth cannot be made sterile for more than a few hours Anti septics satisfy the "aseptic conscience" but probably achieve little else Preparation requires the elimination, as far as possible, of car ious teeth and pyorrhea A thorough cleansing with a mild mouth wash or a solution of 1 1000 aqueous zephiran and a tooth brush, a swabbing out of nasopharyngeal secretions and cleansing of the nasal cavity are obvious precautionary measures To avoid unnecessary contamination, the skin of the patient's face and neck and the mouths and noses of the operating personnel require appropriate attention The tissues of the mouth like the perirectal and perianal tissues possess remarkable healing powers in spite of unavoidable heavy contamination of exposed surfaces during operation and afterwards It is this rather than the surgeon's comparatively feeble aseptic and antiseptic measures which makes surgery of this region possible

Anesthesia may be by local infiltration, field block or in extensive procedures by intratracheal anesthesia The pharynx can then be packed off to prevent aspiration of saliva and blood

It is easy to dislocate the jaw by retraction or by a mouth gag Since the high frequency current or cautery is often required, re tractors, tongue depressors or mouth gags should be made of wood or plastic or protected against contact with electrodes or cautery

The best access to mouth structures is obtained by slight flexion and elevation of the head above the trunk A heavy traction suture through the tongue allows the best exposure to the tongue and neigh boring tissues

Lacerations of the tongue should be sutured because the ir-regularity of the unstitched healed scar may be annoying Leuko plakia should be excised Radium is not effective Small angiomas may be excised, cauterized or radiated, but large ones should be excised A chronic ulcer of the tongue should not be excised or bi opsied until syphilis is first ruled out If it is and a biopsy is to be taken, use a knife, not a cautery, so as not to destroy the usefulness

of the specimen for microscopic study Both radium and surgical excision are satisfactory for *carcinoma of the tongue* (except for carcinoma of the base of the tongue, which is radiosensitive), but the effectiveness of radium can only be judged after some six weeks Since a bilateral excision of the lymph nodes in the neck is required after eradication of the local lesion by either method, surgery is a more rapid method of cure, as the dissection can be done within the six weeks following the local therapy

The neck dissection should be done before palpable nodes are present, but if the nodes are palpable, block dissection is still desirable unless there is fixation of the glands, which signifies extension to the tissues outside the capsule of the nodes In that case, neither surgery nor radiation are of value If the nodes are free of cancer, there is a 30 per cent five year survival rate A radical neck dissection for carcinoma requires that the spinal accessory nerve be divided and resutured The patient should be informed in advance of the consequences

The Lips The lower lip lends itself to a V excision up to one third of its width Plastic procedures are required for larger excisions Partial excision of the upper lip usually requires a plastic procedure for closure

Wounds of the lip should be sutured full depth except for the mucous membrane The unsutured mucous membrane provides drainage and heals well The important point is to get exact approximation of the vermilion border Shellac in alcohol is the best local dressing for lip wounds Do not puncture mucosal cysts They should be excised *Squamous cell cancer* is nearly always on the lower lip, basal cell cancer on the upper lip Lower lip cancer is of low grade malignancy and yields to local surgery or irradiation Local excision alone is usually sufficient if the lesion is not over 1 cm in diameter, not ulcerated or infiltrating, is of brief duration and without nodal enlargement Otherwise, a suprahyoid block dissection is required, whether the nodes are or are not palpable As in the case of the tongue the neck dissection must wait until the local lesion is first completely eradicated Since this can be done immediately after the V excision of the lower lip, but not until six to eight weeks after radiation therapy, surgical treatment is preferable to radiation therapy If the nodes are not involved 80 to 90 per cent five year cures are obtained if they are involved, not over 35 per cent survive for five years

Carcinoma of the cheek requires wide excision or radiation, followed shortly by a unilateral *suprahyoid neck dissection Metastasis*

is slower than in cancer of the tongue Plastic closure of the defect is not done until complete local eradication has been achieved

Epulis requires excision down to and including periosteum This means the extraction of one or two teeth *Carcinoma of the gums* is of low grade malignancy Cautery or diathermy excision is preferable to radiation, which produces excessive bone necrosis After excision, sequestrum will discharge in a few months and healing will occur The nodes are treated as for carcinoma of the lip *Carcinoma of the hard palate* is treated similarly, excising bone where necessary for complete excision, but delaying bilateral block dissection of cervical lymph nodes until these become palpable *Carcinoma of the soft palate* responds well to radiation, but *carcinoma of the tonsil and nasopharynx* is more resistant Surgery is not applicable

Peritonsillar abscess should be drained only after it is localized With the patient sitting up and the back of the head braced, the mucosa is anesthetized by 2 per cent pontocaine applied by a swab to the anterior pillar This is followed by a small incision through the mucosa, which is enlarged by spreading the blades of scissors introduced through the incision Relief promptly follows the evacuation of pus *Retropharyngeal abscess* of pyogenic origin is drained under general anesthesia with the patient flat, the head hanging back over the edge of the table and with suction applied on release of the pus The finger enters the cavity to break up pockets

The *parotid gland* is a dangerous structure to deal with surgically unless its anatomy is well understood The external carotid artery lies below and behind it, then passes along its medial border Just superficial to *it in this region is the facial nerve, which has already* given off branches within the substance of the gland The internal carotid artery and vein lie close to the deep surface also Total parotidectomy is difficult because of processes straddling the posterior margin of the ramus of the mandible and another extending to between the internal carotid artery and jugular vein Incision of the gland for pus should be done early, because the tight fascial investments make it a closed space infection The knife only penetrates the fascia so as to split it in various directions If a *calculus in the duct* is responsible for the infection, an X ray film will reveal it It should be removed and the duct dilated with probes After infection has subsided, if the meatus is narrowed, it should be slit for better drainage

Mixed tumors require surgical excision The patient should be warned of possible damage to the facial nerve Since recurrence is

certain if not fully extirpated, the facial nerve, which usually lies well behind the tumor, will have to be severed if it runs through the tumor In that case it should, if possible, be resutured Sutures, obviously, should not be taken through the gland Malignant lesions require partial resection of the posterior ramus of the mandible to assure radical extirpation

The *submaxillary gland* presents pathologic problems quite similar to those of the parotid, but the simpler anatomy makes its excision much easier and safer Incisions in this region often injure the mylohyoid nerve and produce a droop of the corner of the mouth This eventually recovers The gland is removed in lymph node neck dissections because it contains nodes within its substance

(For the care of thyroid and parathyroid disorders see section on Endocrine Disorders For esophageal diverticulum see chapter on Diseases of Gastro Intestinal Tract)

Thyroglossal cyst is best observed with the head extended Its successful removal requires excision of the sinus tract in the hyoid bone and, if necessary, dissection deep to this point up to the base of the tongue

Ludwig's angina is a closed space infection Pain, dysphagia, elevation of the tongue and floor of the mouth, fever, severe toxemia and a diffuse submental swelling make the diagnosis If it does not yield promptly to antibiotics, failure to drain it in time may result in death from edema of the glottis and asphyxia The incision is never made through the mouth The space must be drained by a circumferential incision in the neck parallel to the mandible One should be ready to do a tracheotomy at any time

Cervical adenitis Do not incise until suppuration is present and fluctuation can be detected If it is tuberculous, and if there is no other tuberculous lesion, surgical excision should be done to save time Sanitarium care is preferable only if there is tuberculosis elsewhere In excision or drainage of cervical adenitis, be careful not to injure the spinal accessory which is very superficial and intimately related to the involved nodes

CHAPTER 12

OTORHINOLARYNGOLOGICAL DISORDERS

Local Anesthesia

The use of cocaine is attended with great danger—5 per cent cocaine in the nose is reasonably safe when mixed with equal parts of 1 1000 epinephrine on thoroughly squeezed out cotton pledgets Two per cent pontocaine is a good substitute for cocaine and much safer

Tonsillectomy

Make sure there is no blood dyscrasia Ignore the formerly accepted practice of roentgenography of the thymus gland Children receive atropine, but not opiates, before operation After operation the patient is kept in slight Trendelenburg position with the head to one side Persistent bleeding demands immediate attention If there is no overt hemorrhage because the blood is being swallowed, violent restlessness and signs of impending shock may appear as the first evidence of bleeding

Fluids are allowed as soon as the patient can take them Adults require morphine postoperatively

If bleeding persists, apply 5 per cent cocaine or 2 per cent pontocaine and follow with a gauze pledget soaked in epinephrine In adults infiltration of the tonsillar bed with novocain and 8 drops 1 ,1000 epinephrine to the ounce of novocain may be used Tie the bleeding vessel if this does not control the bleeding General anesthesia may be required in children Do not suture the pillars Bleeding after the fifth day is due to separation of slough It usually stops spontaneously, and seldom requires interference

Nasal Surgery

Nasal surgery is often followed by discomfort due to occlusion by secretions or exudate Irrigate gently with warm saline gentle suction is applied and a mild astringent instilled The swelling of the cheek after antral procedures is relieved by an ice pack Severe hemorrhage may require ligation of major vessels in the neck

Spontaneous nasal hemorrhage occurs most often from the anterior part of the septum (Kesselbach's area) Have the patient sit up straight Flex the head forward so that the chin touches the chest This prevents swallowing of blood Insert a 1 1000 epinephrine cotton pledget into the nose Compress all soft parts of the nose below the nasal bones between the thumb and forefinger for five minutes by the clock If bleeding continues, insert into the nose a large cotton pledget soaked in equal parts of 5 per cent cocaine and 1 1000 epinephrine If bleeding stops, withdraw the cotton pledget and pack the nose firmly with petrolatum gauze

Postnasal packing should be used for bleeding following adenoidectomy In children bleeding can usually be stopped by pressure in the nasal fossa with gauze impregnated with thrombin

A postnasal plug is inserted as follows In children use general anesthesia, in adults apply cocaine or pontocaine to the nose and nasopharynx Introduce two nasal catheters, one through each of the nares, draw them part way out of the mouth with forceps and tie a strong string to each catheter in the mouth and withdraw the catheters out of the nose Roll two ordinary tonsil sponges together and tie them to the strings which extend from the mouth A third string tied to the sponges comes out of the mouth and is anchored to the face with adhesive so that the sponges may be withdrawn by this string Pull on the nasal end of the strings and force the plug into the nasopharynx behind the soft palate Use an angular forceps behind the soft palate to facilitate this Place a metal tongue depressor between the teeth and insert a finger into the mouth behind the soft palate and push the postnasal plug snugly into the nasopharynx The tongue depressor will prevent the patient from biting the finger A successful postnasal plug is a *large* plug, large enough to bulge the soft palate forward Pack petrolatum gauze into the nasal cavity firmly against the postnasal plug Tie the strings over a piece of gauze across the tip of the nose Remove the postnasal plug in twenty four hours or less

Laryngeal Surgery Edema of the glottis is not uncommon postoperatively It may also develop in children or infants from the trauma of bronchoscopy Intubation or even tracheotomy may be required

Tracheotomy

Tracheotomy, if urgently needed, should be performed early, that is, before the patient is near exhaustion The site of choice is

between the third and fourth tracheal rings, i e, just above the jugular notch

Technic of Tracheotomy Place a pad under the shoulders so that the head extends backwards and the neck is on the stretch Use novocain for local anesthesia

Whenever possible, insert a lighted bronchoscope between the vo cal cords

Make a long, vertical, exactly midline incision from the thyroid notch to the episternal notch between the sternohyoid muscles Do not make a short incision The structures thus exposed from above downwards are thyroid cartilage, cricothyroid membrane, cricoid cartilage, the pretracheal fascia, which suspends the thyroid isthmus immediately below the cricoid cartilage, the thyroid isthmus overlying the first and second tracheal rings

Make a short transverse incision through the pretracheal fascia just below the cricoid cartilage, and separate the thyroid isthmus from the first and second tracheal rings with a Kelly forceps Incise the thyroid isthmus between two vertically placed Kelly forceps and retract laterally This exposes the first four tracheal rings

Remove, with a knife or ring punch, enough cartilage from the third and fourth tracheal rings to accommodate a large tracheotomy tube Insert the tube and close the incision

Emphysema of the skin may follow if the skin is closed too tightly It is safer not to suture the skin at all

Tie the tape holding the tube securely around the neck with a knot (not a bow) so that the tube cannot slip out of the tracheotomy open ing (A snug tracheotomy tape around the neck cannot choke the patient!)

Give orders to the nurse to apply suction to the tracheotomy tube every half hour with a soft rubber catheter Teach the nurse to re move the inner tube of the tracheotomy tube for cleansing once a day

CHAPTER 13

THE BREAST

A mass in the breast of an adult should be considered carcinoma until proved otherwise No compromise with this working rule should be allowed While it is true that, in general, malignant disease displays certain features that are considered characteristic, there are altogether too many instances when it fails to do so "Watchful waiting" because a mass shows all the physical traits of a benign tumor or cyst constitutes a disservice to the patient The youth of the patient should not confer a feeling of security, for the malignancy, if present, is likely to be even greater in young than in old women Nor is the fact that the mass is tiny or that cystic mastitis is present any excuse for delay Transillumination, radiographic evidence, needle biopsy, the presence or absence of retraction, dimpling, elevation of the nipple, bloody or serous discharge from the ducts, etc , cannot compete with an experienced pathologist's examination of the whole excised specimen The psychic trauma of a minor surgical procedure for a mass that proves benign is compensated for by the reassurance that carcinoma is not present Most benign lesions can be removed by incisions that are not disfiguring, such as circumareolar, inferolateral or radial

When a mass is present, palpation should be done with considerable caution because mechanical pressure can disseminate cancer cells

The decision for or against surgery for cancer depends on the presence or absence of metastases If there are distant metastases, beginning with involvement of the supraclavicular nodes, surgery is useless except in the occasional instance when a simple mastectomy for a sloughing ulcerating carcinoma is justified merely to lessen the distress of a discharging, foul smelling lesion Even in the absence of distant metastases ' inflammatory carcinoma" of the breast is not benefited by surgery Occasionally involvement of the opposite breast before or after radical mastectomy justifies a second radical mastectomy because the lesion may still be eradicable

Bleeding from the nipple may be due to Paget s disease, duct papilloma or duct carcinoma If a granulating, ulcerating nipple

shows Paget's cells on biopsy, radical mastectomy is indicated If no mass is palpable, but blood can be expressed from one area of the duct system in the areola, a papilloma may be the cause, but even if it appears benign its excision may not be sufficient To cure the disorder a simple mastectomy may be well advised

A chronic yellowish grumous discharge from the nipple signifies *chronic cystic mastitis* This discharge contains the products of epithelial desquamation in the duct system If biopsy reveals a comedo type of cystic mastitis, the lesion should be regarded as suspicious and probably at least precancerous Breasts which are extensively involved in chronic cystic mastitis, and in which many lumps are present, so that it is difficult to know which, if any, should be biopsied for possible carcinoma, may be removed by simple mastectomy The painful breast of chronic cystic mastitis is said to be related to ovarian hormonal imbalance (For correction of this imbalance see section on "Endocrine Diseases")

Hard, well defined, circular lumps in the areola of children and adolescents are likely to be the result of hormonal influences This type of mastitis subsides spontaneously and requires no treatment

Accessory breasts in the tail of the breast usually become prominent during pregnancy But at other times they may appear as vaguely palpable abnormal masses whose identity is puzzling because of failure to think of this condition There is no good evidence that they are predisposed to carcinomatous degeneration and need not be disturbed unless the patient wishes it for cosmetic reasons

No special preoperative measures are needed in breast surgery The patient should be reassured An air of confidence in the surgeon helps to minimize the overt or concealed fright of the patient If mastectomy is likely, blood for transfusion should be obtained in advance because the average blood loss in a sufficiently radical mastectomy exceeds 750 cc The biopsy should be done under general anesthesia, for a shift from local to general anesthesia is a blunt admission to the conscious patient that she has cancer at a time when psychic trauma should be at a minimum

Postoperative Care

The arm should not be incorporated in the breast binder It should be free to move and to be moved from the first postoperative day, in order to facilitate maximum speed of recovery of function

Radiation therapy before or after operation has proved virtually useless, besides being a large expense and a source of gross discom

fort Radiation therapy for local skin recurrences may be justified occasionally *

Large doses of estrogens (15 mg daily) in postmenopausal women may induce calcification around osseous metastases and so relieve pain in some cases Even visceral metastases are occasionally temporarily controlled by hormonal therapy In premenopausal women, castration by x radiation or by surgery may be indicated and testosterone may be given to inhibit metastatic implants But the breast cancer cell, like the adenocarcinoma cell of the prostate, is subject to hormonal effects up to a certain point only Eventually it asserts an autonomy by which it escapes all control, rendering hormonal therapy valueless

Massive edema of the arm weeks or months after mastectomy usually signifies recurrence There is no satisfactory treatment The edema varies considerably in degree from time to time If erysipeloid reactions occur, chemotherapy is effective in subduing them

* Recent data (G Gordon Taylor et al Proc Roy Soc Med London *41* 118 1948) from a carefully studied large group of patients indicate that simple mastectomy combined with postoperative radiation therapy given in sufficient dose and concentrated within the first few weeks after operation yields the highest cure rate obtainable Moreover the same data suggest that radical mastectomy prior to the radiation therapy gives less satisfactory results than simple mastectomy presumably because the radical procedure only serves to activate cancer cells in nodes that are left behind or disseminated in the axilla

CHAPTER 14

THORACIC SURGERY

The principles of thoracic surgery are based on the physiologic fact that normal respiratory and circulatory function are dependent upon the maintenance of a subatmospheric intrapleural pressure Anesthetic and surgical procedures attempt to keep the functional disturbances resulting from intrathoracic disease or intrathoracic manipulations from exceeding safe limits The following special studies and technics are utilized in thoracic cases in addition to those which apply to general surgical cases

1 Diagnosis

a Sputum Record its gross characteristics and take at least one culture for pyogenic organisms and for fungi and do at least three examinations for tuberculi bacilli When tuberculosis is suspected, concentrate the sputum sediment for microscopic examination, for culture and for guinea pig inoculation Examine stomach washings in the same way If there is a productive cough, record the sputum volume daily on the temperature chart

b Pleural Fluid Record its gross characteristics and microscopic findings Culture all specimens, do a guinea pig inoculation if tuberculosis is suspected Arrange for a paraffin section and smear of the centrifuged sediment for neoplastic cells This requires that the entire volume of pleural fluid removed be delivered directly to the laboratory

c X-ray Studies The x ray examination is probably the most valuable single procedure in the diagnosis of chest disease Bronchography is performed by the radiologist, who introduces the iodized oil through a tube passed into the trachea after topical anesthetization of pharynx and larynx The patient is prepared by mild sedation and by withholding food and fluid so that tracheal aspiration of gastric contents will not occur before revival of the gag or cough reflex Bronchography is not a general diagnostic procedure It is chiefly utilized to delineate the precise areas involved in bronchiectasis

Chemical or allergic irritation of the bronchial mucosa and alveoli from lipiodol may cause or increase existing inflammatory reaction For this reason, subsequent surgery is sometimes deferred for six weeks

d Bronchoscopy, esophagoscopy and thoracoscopy produce considerable discomfort and carry a certain risk They are usually done under local anesthesia and preceded by a twelve hour fast and by morphine and barbiturate medication

These procedures allow direct visualization of lesions, biopsy, securing of aspirated material for microscopic study and some indication of the extent and resectability of neoplastic lesions Bronchoscopy should be done before undertaking resection of neoplasms of the midthoracic esophagus, to exclude invasion of the trachea or bronchi After the procedure watch for hemorrhage, shock or infection Do not allow swallowing of liquid or solid while the pharynx and larynx remain anesthetized

e Pneumothorax is occasionally employed for the delineation of a pulmonary, pleural or chest wall lesion

f Catheterization of Heart and Great Vessels The dynamics and composition of the blood in the right side of the heart and in the pulmonary artery can be determined by passing a long slender catheter into these vessels through an antecubital vein under fluoroscopic guidance The information so obtained is useful in the diagnosis of congenital heart disease and other conditions Such studies are done only under the supervision of the internist or thoracic surgeon in cooperation with the radiologist

g Metastases must be excluded, if possible, before attempting resection of primary lung tumors These may be evident from pressure signs in the mediastinum (esophagus, great vessels, cervical sympathetic, recurrent laryngeal or phrenic nerves, or the lower branches of the brachial plexus) and outside the thorax by symptoms or signs referable to the skeleton, liver and brain Because the lung itself is so often the site of metastases, a primary lesion elsewhere must be excluded before removing a lung tumor

2 *Special Pathologic Physiology*

a Open Chest The normal chest wall is air tight and relatively rigid The lungs remain expanded within the chest by virtue of the atmospheric pressure within the bronchi and alveoli, which opposes the intrinsic tendency of the lungs to collapse by elastic recoil The elastic tension of the normally inflated lung applies a negative pressure varying from approximately 1 to 3 cm of water in expiration to approximately 3 to 6 cm of water in inspiration When an external opening is made into the pleural sac, air enters, the intrapleural pressure rises toward atmospheric and the lung is permitted to collapse at a rate determined by the elasticity of the lung and by the size of

the opening in the chest wall The progressive decline in the negativity of the intrapleural pressure interferes with expansion of the lungs, so that the air exchanged with each respiratory movement steadily diminishes Unless the mediastinal structures are rigidly fixed, the adverse effects of the change in intrapleural pressure also involve the opposite intact pleural sac and lung

The circulation is also disturbed in two ways (1) The normal assistance to venous return provided by the sucking effect of subatmospheric intrapleural pressure is lost, with a resulting reduction in cardiac output, (2) the shift in position of the mediastinal structures causes angulation of the heart at its junction with the great vessels (continuous or pendulum like with each inspiration) so that cardiac output is further reduced and disorders of cardiac rhythm may be provoked An open pneumothorax thus produces a progressive failure of respiration and circulation, accompanied by marked dyspnea, cyanosis and shock, terminating fatally unless quickly corrected

Significant loss of rigidity of the chest wall, such as may follow extensive injury or excessive resection of ribs, by allowing the intrapleural pressure to approach atmospheric, produces the same train of events The same results may follow accidental or surgical lacerations of the lungs or bronchi, inadequately closed chest wounds and *most commonly, improperly cared for pleural catheters which are allowed to admit room air* It is clear that an open wound in the chest must be closed before respiration and circulation have been seriously interfered with

When air has entered the pleural space, it should (except in therapeutic pneumothorax) be aspirated after closing the leak, in order to expand the lung Prolonged open chest surgical procedures are possible only because of technics which prevent collapse of the lungs—particularly by the application of sufficient positive pressure to the bronchi and alveoli *via* a snugly fitting face mask or intratracheal tube In the case of a wide open traumatic pneumothorax, temporarily closed by a large firm occlusive dressing, the lungs must be promptly expanded with oxygen under controlled pressure by means of an anesthesia or resuscitation machine

b Tension Pneumothorax and Tension Hydrothorax Tension pneumothorax results from a valvelike mechanism which permits air to be sucked into the pleural cavity during inspiration and prevents its escape during expiration Narrow and irregular lacerations of the lung surface or, less commonly, of the chest wall may produce this effect Rupture of the lung surface may be spontaneous

or surgical or from trauma, as in rib fracture with or without perforation of the chest wall

Tension pneumothorax or hydrothorax are revealed by the physical signs of air or fluid in the chest, displacement of the mediastinal structures and heart, dyspnea, distention of the superficial veins of the neck, head and upper extremities, progressive cardiorespiratory embarrassment and by x ray examination Early recognition is essential Needle puncture and aspiration should be done immediately, even on suspicion, without waiting for x ray evidence If air or fluid rapidly reaccumulates, continuous closed chest drainage with regulated suction may be required

c Interstitial Emphysema Subcutaneous emphysema is recognized by a characteristic crepitant sensation and by x ray visualization of gas in soft tissues (It should not be confused with the gas produced by Clostridia) The air escapes from the injured lung or bronchus into the interstitial planes of the lung, thence to the lung roots, the mediastinum and upward into the neck Occasionally it breaks through into the pleural space to produce tension pneumothorax As the amount of air increases, the increased pressure in the mediastinum compresses the small and then the large veins with resulting congestion, cyanosis, increased venous pressure, edema of the neck, head and upper extremities, together with progressive reduction in cardiac output and death, if not relieved By the time cardiac action is affected, air will have dissected into the deep and superficial planes of the upper chest and neck Emergency treatment consists in (1) intravenous infusions to raise the venous pressure to a level required to fill the heart and maintain cardiac output and (2) reduction of mediastinal pressure by providing a vent in the superior mediastinum This is done through a low neck incision with blunt dissection substernally so as to assure entry into the deep as well as into the superficial planes The inhalation of 100 per cent oxygen continuously for eight to twelve hour periods will reduce the pressure of trapped nitrogen, provided the leak has sealed off (See Oxygen Therapy, and Intestinal Distention) Chemotherapy should be given because of the danger of mediastinal infection

d Air Embolism The pressure within the veins of the chest, like the intrapleural pressure, is subatmospheric, particularly during inspiration Thus an open vein in the chest wall or exposed lung may suck air into the lung veins or directly into the left auricle Fatal air embolism is rare, because of efficient screening by the lung capillaries But a small amount entering a branch of a pulmonary vein may plug a coronary or cerebral vessel Hence, opened veins about

the thorax should be ligated promptly If air aspiration is suspected, 100 per cent oxygen should be given at once to hasten the absorption of nitrogen in the air bubbles in the blood stream

e Tracheal Obstruction Major obstruction occurs at the glottis or larynx by a large food bolus, artificial teeth, acute edema, and the like Remove the foreign body via a laryngoscope or do a tracheotomy at once (See chapter on Otorhinolaryngology)

Incomplete degrees of laryngeal or tracheal obstruction may produce anoxia, which is relieved temporarily by a mixture of oxygen (20 per cent) and helium (80 per cent) (See Oxygen Therapy) Incomplete bronchial obstruction may cause regional emphysema or atelectasis The atelectasis may be entirely silent until infection sets in from the absence of air and therefore of effective cough Silent atelectasis requires early intervention to forestall infection

"Traumatic wet lung" is a particularly dangerous situation in which a profuse endobronchial discharge occurs

The prevention or treatment of bronchial obstruction includes aerosol medication and other chemotherapy, postural drainage, inhalation of oxygen or oxygen helium mixtures and endotracheal or endobronchial aspiration The latter is used whenever the patient cannot effectively relieve respiratory distress from secretions

3 Special Procedures

a Aspiration of the Chest The site of aspiration is determined by the location of the material to be withdrawn Air is usually aspirated through the second interspace anteriorly, free fluid at the posterior axillary line between the seventh and eighth rib, with the patient in as near a sitting position as possible, supported by a second person because of possible syncope A high diaphragm necessitates a higher tap to avoid penetrating the diaphragm A tap for encapsulated fluid is made after careful x ray study with the radiologist If the fluid is purulent, use an 18 or 16 gauge needle Otherwise use a 19 gauge needle passed through a rib interspace, using aseptic precautions and sterile gloves Procaine (1 per cent) is infiltrated into the full thickness of the chest wall with care to anesthetize the parietal pleura, the resistance of which can be detected by the needle tip Test equipment in advance and apply continuous mild suction so as to recognize the needle's entrance into the pleural sac by the recovery of fluid If the fluid is considerable, use a three way stopcock with the sidearm connected to a rubber tube, without allowing air to enter the pleural sac Continue aspiration as long as there is no discomfort Stop the aspiration if respiratory or circulatory distress ap

pears Record volume and gross appearance of fluid on the laboratory sheet and arrange for laboratory examination of the fluid

b Postural Drainage Adjust the patient's position so as to secure the most effective drainage of the involved bronchial system Three dimensional diagrams of the bronchial tree are available in order to find the appropriate position for gravity drainage * The duration and frequency of the periods of postural drainage will depend on the results of the first trials Begin with a fifteen to thirty minute period several times each day

c Bronchoscopic Aspiration This may be a life saving procedure when other technics of clearing the bronchial passages fail

d Closed chest drainage is used prophylactically to prevent the accumulation of pleural fluid or air following a thoracotomy A snugly fitting catheter will have been introduced at the time of operation or a small catheter (No 12 to No 16) may be introduced through a trocar into the appropriate interspace

The catheter is connected by a sterile glass adapter to a length of sterile rubber tubing which must be clamped until its end is safely immersed under water or attached to suction If a simple water trap is used, the end of the rubber tubing is attached to a length of glass tubing which passes through a two hole stopper and ends several inches below the surface of the water The second hole is left empty (Simple dropping of the end of the rubber tubing into water in a bottle is not safe because the end of the tubing often coils or floats to the surface of the water, admitting air freely into the pleural space) The water bottle is placed on the floor at the bedside or is suspended several feet below the level of the patient The tubing must fall in a smooth line from chest wall to bottle Avoid dependent loops since they act as traps

Efficient pleural drainage plus rapid re expansion of the lung may be achieved by suction instead of gravity drainage Suction is applied by tubing from a suction line to a glass tube in one hole of a three hole stopper in a valve bottle which acts as a trap for the exudate This glass tube and one other in the second hole of this stopper project only a short distance into the bottle The third hole admits a long piece of glass tubing of larger diameter, the upper end of which is open to the air while the lower projects just 2 inches below the surface of the water, in order to limit the amount of negative pressure The second glass tube connects with the second hole in the stopper of the collecting bottle Both glass tubes in the collecting bottle are

* Badger T L Bronchiectasis Treatment and Prevention New England J Med *237* 937 1947

short and water is omitted Adjust the suction so that a slow, continuous stream of air bubbles is drawn through the water

Precautions (1) Clamp the tube leading to the chest whenever the trap bottle or collecting bottle is opened (2) Use heavy walled tubing of adequate diameter to avoid kinking and to assure proper function, do *not* use small glass adapters or medicine droppers to make connections (3) Keep tubing sterile at the pleural end, in case of reflux into the chest (4) Keep both bottles well below the bed level to prevent aspiration into the chest in case of failure of suction (5) The water level in the trap bottle will drop by evaporation If not replaced, the suction will steadily diminish and ultimately air at atmospheric pressure will be allowed to enter the chest

e Open Chest Drainage When the visceral and parietal pleurae have become adherent about an area of inflammation, open incision for drainage is not followed by pneumothorax The incision may require the resection of one or more rib segments Short, large bore rubber tubes are usually used as drains These must be kept anchored by safety pins securely attached by adhesive strips to the chest wall so that they will not move in or out Capacity of the cavity is determined by occasional fillings with measured volumes of saline or by x ray study with or without lipiodol instillation Drainage must be maintained as long as there is any evidence of a residual cavity or persisting bronchial fistula

4 Chest Injuries

a Nonpenetrating trauma to the chest usually injures only the chest wall Before applying local therapy, intrathoracic injury should be looked for by clinical examination and by x ray films Comfort is usually increased by a 3 to 4 inch adhesive strapping, applied in full expiration, encircling the lower chest, regardless of the site of injury If the strapping increases the pain (depressed fracture of rib), remove the strapping at once If there is pleural or lung damage, keep the patient in bed and start chemotherapy Intercostal nerve block may be useful to alleviate dyspnea and pain

If the injury was over the heart and there is excessive tachycardia, weakness, dyspnea, palpitation or arrhythmia, keep the patient at complete bed rest and arrange for electrocardiogram and cardiac consultation

b Penetrating Trauma The opening in the chest wall must be closed immediately by whatever means are at hand A packet of sterile towels will do This seal is maintained until the lung can be kept inflated by positive pressure anesthesia An extensively weak

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ened chest wall should be stabilized by appropriate dressings to avoid paradoxical respiration No special effort is made to remove a bullet, but all dirt, clothing, bone fragments and other foreign bodies which can be found are excised during the debridement This may require partial lobectomy Continuing severe intrapleural bleeding usually comes from an intercostal or the internal mammary artery Ligature through the wound or through a separate incision is necessary Bleeding from a pulmonary laceration usually stops spontaneously The wound in the chest wall is debrided and closed

Blood in the pleural space must be aspirated to allow normal expansion of the lung and prevent the accumulation of a huge clot, which may undergo organization and form a constricting shell over the lung The withdrawn blood is not replaced by air Air leaking from torn lung may require repeated or continuous aspiration A thoracotomy tube with one end under water, left in place for forty eight hours, may obviate repeated aspirations

Lacerations of the heart cause exsanguinating hemorrhage or increasing intrapericardial pressure Transfusion in the latter instance is given to raise the venous pressure and maintain cardiac output in spite of the increased intrapericardial pressure Immediate suture is required

Penetrating injuries of the chest frequently involve abdominal structures When both chest and abdomen require surgical therapy, the first incision is directed to the injury most threatening to survival As a rule the chest will be opened first If the injury is on the left side, transdiaphragmatic exploration can be done through the same incision The situation is rarely so urgent that time cannot be taken to treat shock and take x ray films Remarkable improvement in a desperate situation may result from occlusion of sucking wounds, oxygen therapy blood transfusion, intercostal drainage and intercostal nerve block

Perforation of the Esophagus The traumatic form usually results from a foreign body or instrumental injury Virulent mediastinal cellulitis from mixed infection by aerobic and anaerobic organisms from the mouth is virtually certain A perforating foreign body must be removed at once Drainage of the mediastinum may be needed, but maximum doses of chemotherapeutic agents will control most instances of early spreading mediastinal infection Give nothing by mouth If the injury is low the esophagus *above the lesion* may be drained of saliva by an inlying tube attached to suction If a mediastinal abscess forms, it can be drained by a low cervical incision or by posterior mediastinotomy

Preoperative Care

In all patients who are to undergo chest surgery chest films are taken in addition to studies required for determining the functional status of the cardiorespiratory apparatus These studies include vital capacity and its subdivisions, arterial oxygen saturation, cardiac output and electrocardiogram

Nonsuppurative Disease of the Lung, Mediastinum or Stomach No special preoperative care is necessary, but oral and nasal sepsis must be minimized if not eradicated Full doses of pen icillin should be given for twenty four hours before operation Do not use sulfonamides prophylactically If the surgery involves the esophagus, vagus nerves or stomach, pass a Levin tube to facilitate handling of the esophagus during operation and to deflate it and the stomach postoperatively Make no effort to get the tube beyond an obstructing lesion

Cancer of the lung is predominantly a disease in men of middle and advanced age The operative mortality for total pneumonectomy is now under 4 per cent and is comparable to that for malignant disease elsewhere But the lesion when first seen is already inoperable in three to four out of five patients This is because the disease is so often silent until the effects of bronchial obstruction force the patient to seek relief Routine periodic scout films of the lungs are not likely to disclose early cancers But the physician should at least be aware of the earliest symptoms, which not infrequently first appear after an acute respiratory infection These symptoms are (1) cough of unusual duration, (2) slight but persistent hemoptysis, (3) a wheeze that even the patient is able to localize to one side of the chest, and (4) loss of weight out of proportion to the extent of the lesion Oc casionally the earliest sign is pleural fluid, which is likely to be bloody and to show cancer cells The diagnosis and course of treat ment is determined largely by the findings of the roentgenologist and the bronchoscopist X ray films in various positions, spot and grid films and fluoroscopy provide essential data which the broncho scopist supplements by obtaining a biopsy, determining the fixity of the tumor, observing the presence of widening of the carina by en larged subcarinal lymph nodes and orienting the surgeon as to the level for division of the bronchus The biopsy, supplemented by microscopy of the secretion aspirated from the region of the mass, provides a definite diagnosis of cancer in some 80 per cent of patients with carcinoma The remainder are likely to have lesions too periph eral for access and may require thoracoscopy or thoracotomy in order to make the diagnosis Bronchography is undesirable and un

necessary Solitary tumors in the periphery should stimulate a search for a primary lesion elsewhere, especially in the kidney Occasionally such a "tumor" is a relatively inactive uncalcified tuberculous lesion, which may reveal itself by a positive sputum For this reason, if thoracotomy is necessary for diagnosis, the biopsy is best performed by excising the entire lobe to prevent spillage of the caseous material, if present

Total pneumonectomy is the only operation for carcinoma The operation should not be undertaken unless there is a reasonable chance of substantial benefit This can be expected if the lesion is localized and even if a few neighboring lymph nodes are involved, but not if the pleura or mediastinum or a distant organ is invaded, and not if the malignant cell is highly undifferentiated or the oat cell type

Preoperative and Postoperative Care

Accompanying pneumonitis or abscess will not yield to chemo therapy if it is due to and lies distal to a blocked bronchus Drainage of an abscess or complicating empyema provides worth while relief even in an inoperable case

Cardiovascular complications, such as arrhythmia or flutter, may occur postoperatively The operation as now performed leaves the chest closed The dead space is obliterated by mediastinal shift, by elevation of the diaphragm and by organizing exudate A subsequent thoracoplasty is rarely necessary Since only one lung is left, fluids should be given postoperatively with caution to avoid pulmonary edema

Suppurative Disease of the Lung Appropriate antibacterial therapy is given parenterally and by inhalation Postural drainage and tracheal or bronchoscopic aspiration are done and repeated as necessary The patient must not be sent to the operating room with the bronchial tree loaded with exudate because he will usually be placed so that the diseased lung is uppermost and the good lung may then become filled with exudate Asphyxia or cross infection may re sult because of the absence of the cough reflex To preserve the cough reflex a patient with suppurative disease should not be heavily se dated prior to operation Good clearance by cough and by postural drainage for at least one half hour before operation should be secured

Anesthesia

Ether or cyclopropane, in a closed system with an intratracheal tube, is used for open chest work Local anesthesia, supplemented

when necessary by field block, is preferred for drainage of an empyema or lung abscess Topical anesthesia (pontocaine preferred) is used for bronchoscopy and should be preceded by adequate sedation

Postoperative Care

Postoperative cardiorespiratory disturbances may lead to sudden death Frequent and close observation, particularly in the first forty eight hours, is required by one familiar with the early signs of serious complications The nurse's notes must supply full and frequent details on respiratory rate, cyanosis, pulse and blood pressure readings Observe the pulse, the degree of cyanosis, the type of breathing, the sputum, displacement of the trachea or apex impulse and evidence of intrapleural fluid or air Do not hesitate to use portable x ray examinations and to do chest taps as diagnostic aids Drainage suction apparatus should be checked frequently

Pleural Air, Fluid and Infection When the chest has been closed without drainage, the adverse effects of the accumulation of air or fluid upon intrapleural pressure and upon the lung must be avoided by aspiration or by instituting closed catheter drainage The chest cavity is not ordinarily drained or tapped after pneumonectomy, because it is desired that the empty hemothorax be filled with sterile transudate Abnormal tension due to such fluid, however, must be relieved by tapping An excessive volume of pleural fluid is often early evidence of pleural infection The most dangerous variety of pleural infection is due to leakage from a bronchial suture line This does not ordinarily appear until four to seven days have elapsed

When the chest has been closed with catheter drainage, routine irrigation of the catheter is avoided because of the danger of pleural infection Mediastinal dissection at operation may have opened the opposite pleural sac and this too may become infected Pleural drainage is discontinued as soon as possible, i e , when the pleural exudate is negligible and the lungs are well expanded, usually in forty eight hours or less Penicillin is generally continued for at least a week postoperatively If there is gross contamination at operation, penicillin is put into the pleural sac and may be repeatedly instilled with sterile precautions through the pleural catheter, which is clamped for two hours after each instillation

Pleural infection from a leaking bronchial stump requires prompt identification of organisms and vigorous systemic chemotherapy, as well as continuous closed catheter suction drainage, succeeded by open thoracotomy when frank suppuration develops

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Pleural infection from a leaking bronchial stump requires prompt identification of organisms and vigorous systemic chemotherapy, as well as continuous closed catheter suction drainage, succeeded by open thoracotomy when frank suppuration develops

Loss of Chest Wall Rigidity The chest wall which has lost the support of its ribs will require immobilization to prevent inward motion with respiration This is accomplished by bulky pressure dressings applied with elastic adhesive and swathes, supplemented, if necessary, by sandbags or a plaster of paris jacket

Pulmonary infection can be aggravated by the careless use of seda tives or narcotics Local anesthesia or intercostal nerve block for a painful wound enables cough to be effective Deep breathing will help prevent or correct atelectasis When secretions are profuse and cannot be satisfactorily brought up, repeated tracheal aspiration or, if necessary, repeated bronchoscopic aspiration should be done

It is assumed that there is sufficient interference with pulmonary function following major intrathoracic procedures to warrant the routine administration of 100 per cent oxygen for at least forty eight hours after operation

Pleural Empyema

The incidence of this disorder has declined to an almost insignifi cant figure because of the successful treatment of pulmonary sup puration by antibiotics Aspiration, parenteral chemotherapy and the local instillation of penicillin or streptomycin is the preferred method of treatment so long as the exudate is such as to indicate that a firm gluing of visceral to parietal pleura has not yet taken place Even so, aspiration, which is done generally once a day only, may not keep pace with the rate of accumulation of fluid When this is the case, closed air tight catheter drainage may be instituted As soon as the exudate consists almost entirely of pus cells and fibrin, a walled off abscess may be presumed to be present and open drain age by rib resection is required to allow sufficiently free drainage and obliteration of the cavity To open the chest prematurely, i e , before walling off occurs, may be disastrous because (1) the re sulting loss of negative intrapleural pressure prevents full expansion of the lung, whose vital capacity is already limited, and (2) if the mediastinum is not stabilized, the opposite uninvolved lung will also suffer a decrease in expansibility

During the period of aspiration therapy, the appropriate anti biotic is introduced after each aspiration (See chapter on Surgical Infections) Fluid withdrawal is interrupted when the patient feels sharp pain, indicating complete extraction of fluid or the need for time to allow the re expanding lung to adjust itself The aspiration should not produce too great a negative pressure This will be avoided if only a syringe and needle are used for the purpose Oc casional repeat specimens for culture of the fluid should be taken

If tube drainage is required, the most dependent area, located by x ray films in various planes, will be selected for insertion of the tube The advantage of tube drainage is not only the constant evacuation of exudate, but the more rapid re expansion of the lung and collapse of the cavity as a result of the suction effect of gravity drainage into a bottle below the bed Following open chest drainage, the size of the cavity is determined from time to time by measuring its capacity for saline solution If a bronchopleural fistula is present, the patient will cough and taste the solution Most of such fistulas will close spontaneously and in a short time If a fistula persists, the empyema will become chronic

X ray films are taken often to determine size, shape and position of the cavity, lung expansion, mediastinal shift, and the like

The cavity must be drained until it is entirely obliterated If fever and malaise persist, premature closure or a secondary pocket of pus is the probable cause

Massive Collapse of the Lung

This is a rare postoperative complication, probably due to bronchial occlusion by a plug of mucous or mucopurulent exudate The atelectasis is easily detected by observing in addition to fever, dyspnea, cyanosis, etc , narrowed rib spaces on the involved side and a shift of the heart and mediastinum to that side—by physical examination and by roentgenography Bronchial aspiration and chemotherapy will correct the disorder within a few days

Esophageal Anastomosis A Levin tube with suction is always placed above the suture line to remove air and saliva for thirty six to forty eight hours The tube is then removed and small sips of water allowed Other liquids, soft and semisolid foods are then added as tolerated

Vagotomy

(See "Peptic Ulcer" page 142)

Postoperative Care Severe gastric distention in the first forty eight hours is avoided by suction through a Levin tube and by avoiding oral fluids or food Gastric emptying may continue to be markedly retarded for some time longer, so that feeding will depend on recovery of peristaltic function "Urecholine" may be used to stimulate gastric peristalsis Vagotomy is never performed in the presence of pyloric obstruction, unless accompanied by a gastroenterostomy There is an increasing tendency to utilize the trans abdominal approach to the vagus nerves because of the need of observing the nature of the local lesion

CHAPTER 15

SURGICAL DISEASES OF THE GASTRO INTESTINAL TRACT*

THE ESOPHAGUS

Esophageal Diverticulum The commonest type arises from the posterior wall of the lower pharynx at the level of the inferior constrictor muscle and presents on the left side of the neck Its wall consists of mucosa and submucosa and lacks muscle and serosa The patient feels throat irritation, has an irritative cough and regurgitates mucus and food free of gastric juice, especially after a meal, when bending over or lying down at night Traction or compression of the esophagus by the diverticulum narrows its lumen and produces dysphagia, with resulting weight loss and occasional aspiration pneumonitis Pressure on the neck may flood the mouth with fluid or food A swallow of barium may confirm the diagnosis

The esophagoscopist may be asked to insert a lighted rod into the pouch at operation better to identify the sac for the surgeon Occasionally diverticulectomy is followed by narrowing at the site of repair so that bougienage may be required

Cardiospasm The upper two thirds of the esophagus is lengthened and dilated and therefore S shaped, while the lower third is smooth and narrowed If the x ray study suggests carcinoma, it may be due to the distortion caused by retained food particles Wash out the esophagus and repeat the x ray study The syndrome may be associated with megacolon, megaureter, etc The symptoms are pain, dysphagia and regurgitation of undigested food Pain may be severe and colicky, radiating substernally, to the back of the neck, the left shoulder or chest It may simulate biliary colic or angina pectoris The patient cannot swallow liquids, especially if cold He may learn to fill the pharynx with semisolids and then force them through by swallowing water with the glottis closed The retained food may cause hiccough and regurgitation may cause cough or pneumonitis Weight loss is marked

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* (For acute disorders of the gastro intestinal tract see chapter on Acute Abdominal Disorders)

Surgical treatment by anastomosing the dilated esophagus to the stomach through a transthoracic incision is sometimes necessary in cases which resist bougienage The ligament between the diaphragm and esophagus close to the cardia may be the cause of the obstruction and should be severed at operation

Acute esophagitis is a not uncommon lesion producing dysphagia, substernal pain and profuse salivary expectoration It occurs in surgical patients with prolonged vomiting or from nutritional deficiency postoperatively or in patients intubated for many days

Carcinoma of the esophagus occurs characteristically at the level of the cricoid cartilage, tracheal bifurcation or at the cardia, the three points of physiologic delay in swallowing The chief symptom is progressive dysphagia Aside from a dull retrosternal discomfort there may be no pain Regurgitation and weight loss result Hiccough may occur Biopsy by the esophagoscopist and x ray films confirm the diagnosis Bronchoscopy to rule out invasion of the trachea is done preoperatively (For further data see the chapter on Thoracic Surgery)

The intrathoracic esophagus can be resected and the mobilized stomach anastomosed to the proximal end as high up as the superior border of the aortic arch

Dysphagia may also be due to aortic aneurysm, diaphragmatic hernia, mediastinal tumor, scleroderma or myasthenia gravis

Diaphragmatic Hernia

A protrusion of a varying portion of the gastric fundus covered by peritoneum so as to form a sliding hernia protruding through a patulous cardiac orifice of the diaphragm is a not uncommon finding in middle or advanced age Small ones are probably of no clinical significance Large peritoneal protrusions into which other organs as well as the stomach may project may also be symptomless but frequently are painful Aside from the para esophageal type there is a more outspoken type which is due to (1) congenital failure of fusion of the several sections of the diaphragm and is therefore manifest in infancy or early childhood, and (2) following traumatic dehiscence of the diaphragm The symptoms may be vague and misleading because of the variety of viscera which may become incarcerated in the hernial ring The symptoms are prone to occur during the night, on lying down or after a large meal Pain simulating angina and vomiting are the most prominent symptoms Borborygmi in the chest may lead

to the correct diagnosis The latter is conclusively affirmed by roent genography If chronic secondary anemia and stools positive by the guaiac test are present, bleeding from ulceration of a mildly strangu lated portion of the cardiac fundus is the probable cause

Repair is performed via a thoracotomy or laparotomy, depending on the location and extent of the hernia and on the preference of the surgeon The visualization and handling of the viscera and hernial sac are usually better dealt with via a thoracotomy incision through the left eighth interspace

THE STOMACH

Diagnostic Procedures

The diagnosis of intragastric lesions occasionally requires *gastroscopy,* which is useful in the diagnosis of (1) unexplained hemorrhage, (2) gastritis, (3) gastric ulcer and recurrent ulcer after surgery, and (4) carcinoma, especially of the cardia It should not be attempted in the presence of aortic aneurysm, angina pectoris, dysp nea, dorsal kyphosis esophageal obstruction, diverticulum or varices

X ray studies should precede gastroscopy The patient is prepared for gastroscopy as follows He is starved overnight In the morning dentures and glasses are removed and the usual preoperative medica tion is given The patient is instructed to gargle 2 per cent ponto caine, which is instilled with a medicine dropper behind the tongue until 15 to 30 cc has been used Once anesthesia of the pharynx is achieved, the stomach, if obstructed, is first emptied by a large tube the contents being drained by putting the patient in the Trendelen burg position

After the test *nothing* is allowed by mouth for two hours In struct the patient and the nurse about this or aspiration pneumonia may result

Gastric Analysis Intubation is performed as follows Starve the patient after 10 P M Remove dentures The patient is put in the sit ting position Observe for deviated septum Lubricate the tube with mineral oil and insert it gently into the roomier nostril Instruct the patient to continue swallowing and, if there is difficulty, give the pa tient sips of water Gagging or nausea can be controlled by deep breaths through the mouth Push the tube down to the third marker and then let the patient lie down Aspirate the stomach completely, turning the patient from side to side to assure this Record total gastric volume, deducting the amount of water swallowed during passage of the tube, and test for free acid with Congo Red paper

Standard Tests

Alcohol Instill 100 cc of 7 per cent alcohol by gravity and aspirate as completely as possible after fifteen, thirty, forty five and sixty minutes, testing each sample with Congo Red paper Record volume of each specimen and place at least 10 cc in a properly marked test tube Withdraw the tube if free hydrochloric acid is shown to be present by the dye

Histamine If no free hydrochloric acid is present, give 0 1 cc per kg /b w of 1 1000 histamine subcutaneously, unless contra indicated by hypertension, cardiovascular disease, extreme old age or hypersensitivity to histamine Aspirate completely after twenty minutes and record volume Test for free acid Put at least 10 cc in a properly marked test tube Histamine acts by a local direct stimulus on the chief cells of the stomach

Reactions to histamine are local pain, wheal and erythema pounding headache, tachycardia, flushing of the face They are transitory

Insulin acts through vagal stimulation Hypoglycemia stimulates the vagal nuclei to secretory and motor responses If acid does not appear after insulin, both vagi to the stomach are functionless The test is useful to assess the extent of psychic secretion and to deter mine the completeness of vagotomy for peptic ulcer

Material required for this test consists of four bottles containing anticoagulant for blood samples, nine labeled test tubes, insulin and insulin syringe, 30 cc syringe, 19 gauge needles, a 50 cc ampule of 50 per cent glucose, syringes and needles for blood samples

Take a fasting gastric specimen and a blood sample for the fasting blood sugar level Then inject 15 units of regular insulin Aspirate gastric secretion every fifteen minutes for two hours and take blood for glucose levels at one half, one, and one and one half hours The test is not reliable if the blood sugar does not fall below 50 mg per 100 cc or if duodenal regurgitation has occurred Give glucose in travenously if a hypoglycemic reaction occurs

Neutral Red Test Unlike histamine, the neutral red dye test produces relatively constant responses in the same individual It tests the excretory function of the parietal cells, which eliminate the dye into the stomach Since the dye is excreted also into the biliary passages, the duodenum and the entire small bowel, it may rarely be found in the stomach as a result of regurgitation The response to the dye test is more sensitive and more reliable as an index of achlor hydria than is the response to histamine When there is absence of excretion of dye, achlorhydria is always present When there is

excretion of dye, the histamine test will demonstrate free hydrochloric acid on a second or third trial, if a first one is negative

To perform the test, a Levin tube is passed in the usual manner after an overnight fast and the stomach is aspirated until completely empty Inject 5 cc of a 1 per cent dye solution (50 mg) intravenously Take small samples of gastric contents at one minute intervals for thirty minutes Note the time when the dye first appears and the *time it takes to reach maximum concentration* *The average appearance time is four minutes, and the average maximum concentration time is fourteen minutes* The upper limits of normal are nine minutes and twenty minutes, respectively

Carcinoma of the Stomach

The diagnosis is seldom made early unless the lesion obstructs the cardia or pylorus or results in severe bleeding Loss of weight, nausea, anorexia and constipation are among the first symptoms Anemia and pain tend to occur later Gastric acidity is usually low or absent, but there are occasional instances of normal or high acidity Many patients who are treated for symptoms and x ray signs of gastric ulcer in fact have a carcinoma It behooves the physician to assume that a gastric ulcer is a carcinoma unless proved otherwise The proof that the lesion is an ulcer is x ray evidence of complete healing *of the "ulcer" combined with symptomatic cure within a few weeks* after treatment is started Such proof is at best precarious Since chronic gastric ulcers in any case are notoriously resistant to cure by nonsurgical therapy, they, like carcinoma, should be considered surgical lesions soon after the diagnosis is made Gastric washings processed by Papanicolaou s method may reveal carcinoma cells before the diagnosis is or can be made by x ray or gastroscopy studies

Perforation of a gastric carcinoma generally occurs late in the disease If emergency surgery following a diagnosis of "ruptured peptic ulcer ' discloses a perforation due to gastric carcinoma, simple closure of the perforation is not sufficient even as a temporary stop gap, because the postoperative mortality is high Radical resection should be performed if possible at once

Preoperative Preparation Anemia, fluid and electrolyte imbalance, vitamin deficiency and other nutritional defects are corrected as far as possible Delaying operation to correct malnutrition is justified only if the measures employed are in fact achieving this purpose If they are not, undue delay increases an already sufficiently grave risk Streptomycin by mouth for several days preoperatively may be of some value in obtaining a relatively bacteria free stomach

and duodenum when the acidity is low or absent, but it is of doubtful value in operation for ulcer or carcinoma if the acidity is high The stomach is lavaged three or four hours after the evening meal of the day before surgery is performed and again on the morning of operation The contents are aspirated and several pints of 1 per cent sodium bicarbonate solution are used for cleansing the mucosa The tube is left in place

Gastric carcinoma can be resected by a transabdominal or transthoracic approach or by a combination of the two, which is achieved by transecting the costal margin and diaphragm The x ray findings cannot be relied upon to determine resectability This must be decided at operation unless advance evidence of distant spread is disclosed by discovering pelvic implants, a positive Virchow's gland, hepatomegaly or other metastatic implants Considerable symptomatic relief can often be provided by excision The five year survival rate is 35 per cent for early, and 5 per cent for late cases

The postoperative care is similar to that for peptic ulcer (See page 143)

Pyloric Obstruction

This is usually due to peptic ulcer When due to carcinoma, surgery is indicated This is not always so in peptic ulcer because organic obstruction by scar is rare Spasm or edema or both may be the cause and can frequently be relieved by proper conservative management

The delay in gastric emptying, especially when associated with vomiting, results in progressive loss in weight, nutritional deficiencies and stigmata of vitamin imbalance, dehydration, loss of chlorides and alkalosis Decreased blood volume and alterations in electrolyte balance lead to impaired renal function, oliguria, increase in the nonprotein nitrogen level of the blood and a rise in the carbon dioxide combining power The urine may contain albumin and casts ("alkalosis nephritis") Clinical symptoms of alkalosis may appear irritability, headache, nausea, vomiting, paresthesias, tetany, positive Chvostek and Trousseau signs The relative starvation may at times be associated with ketosis and ketonuria in the presence of clinical alkalosis The stomach dilates progressively, peristaltic waves become feeble and ineffectual and retention leads to hypersecretion in a vicious cycle The mucous membrane becomes involved in a secondary gastritis and the gastric wall may become edematous The lower border of the stomach may descend to the left lower quadrant

Diagnosis Both clinical and x ray evidence are required to establish the diagnosis The history is of particular importance Although there are rare cases in which an advanced degree of obstruction is found without any history of vomiting, the usual clinical picture is that of vomiting of a large amount of fluid and partially digested food in the late afternoon or evening, i e , after the stomach has become overloaded from eating during the day There may be distention of the upper two thirds of the abdomen as the huge stomach fills with retained contents A succussion splash may be elicited on shaking the area with the palm of the hand Occasionally visible peristalsis s evident, proceeding from the left upper quadrant diagonally across to the right

X ray examination with the barium meal reveals a high grade retention after six hours X ray evidence alone, however, may be misleading in the diagnosis, since delay in emptying is seen occasionally in the absence of any organic disease, as the result of a temporary functional motor disturbance or spasm due to psychic stimuli In case of doubt repeat the examination a week later

Gastric aspiration before breakfast or in the late evening will often give reliable information The fasting stomach should not contain more than 100 cc of fluid The routine morning aspiration can be modified by giving a full "motor meal" the preceding evening, including raisins containing seeds The aspirated contents are then examined for retention of the seeds Evening aspiration is performed four hours after the last meal of the day The patient should be instructed to abstain from taking water or food after supper Normally under these circumstances, the stomach contains not more than 250 to 300 cc

Treatment The objectives of treatment are decompression of the stomach, restoration of chemical and fluid balance, improvement of renal function and correction of nutritional deficiencies To attain these ends the various therapeutic procedures are initiated promptly and in quick succession

Gastric aspiration followed by lavage with a solution of 1 per cent sodium bicarbonate in warm tap water is performed two or three times daily at regularly scheduled hours The first lavage is given on rising and the last just before retiring The time of aspiration and the amount obtained are recorded accurately on a special sheet so that comparisons can be made from day to day to indicate the course of the disturbance

A bland liquid diet is given in amounts up to 4 ounces at intervals of one or two hours When the two hour schedule is followed, one of

the colloidal gel anti acids is given in 2 ounces of water on alternate hours The mainstay of the diet consists of milk and cream mixtures, thin gruels and milk or cream soups Water at room temperature may be taken in small amounts as desired The advantages of amino acid mixtures over undigested protein for marked malnutrition in these circumstances are more than questionable

Intravenous infusions are begun without delay after a blood sample is taken for determination of nonprotein nitrogen, carbon dioxide combining power and chlorides During the first few days it is usually advisable to give a daily minimum of 3000 cc of 5 per cent glucose in normal saline Thereafter 2000 cc of 5 per cent glucose in distilled water or normal saline is ordinarily sufficient It should be noted that frequent gastric aspirations may result in a deficit of water and chlorides, so that these patients may tolerate a larger amount of parenteral water and salt than ordinarily Vitamin supplements such as B complex and ascorbic acid should be added to these solutions The use of parenteral amino acid mixtures in marked cachexia is not helpful unless the total caloric requirement is being met and they are properly proportioned to meet nutritional requirements

To overcome spasm of the pylorus, atropine sulfate is administered subcutaneously in doses of 0 4 mg three or four times daily to full physiologic effect Administration of atropine or belladonna by mouth is usually ineffective in pyloric obstruction due to impaired absorption When sedatives are necessary, they are best given parenterally

Accurate charts are kept indicating the total fluid intake and output The volume of urine for each twenty four hour period is determined accurately Frequent urine analyses are made until abnormal findings have disappeared The blood chemistry determinations are repeated every second or third day until normal levels are obtained

In the case of peptic ulcer the treatment outlined is continued for ten to fourteen days In carcinoma there may be little or no improvement, so that only as much time prior to surgery should be taken as is essential to restore fluid and electrolyte balance, satisfactory renal function, and to correct nutritional and vitamin deficiencies—all of which may have to be done by parenteral therapy Improvement is manifested by a progressive decrease in the amount of gastric contents recovered by aspiration at corresponding times of the day, by improved urinary output, disappearance of abnormal urinary findings, return of blood chemistry to normal, subsidence of symptoms of alkalosis and a true gain in weight, in other words, one not due to

water retention When it becomes evident that the obstruction due to spasm or edema is being relieved, gastric aspirations can be de creased to one every evening, the diet increased to include soft foods and the intravenous infusions discontinued

When, in the case of peptic ulcer, the trial period of medical man agement has been completed and a high degree of obstruction is found to persist, operation is necessary In most patients the period which has elapsed is not to be considered as wasted in time or effort, since the patient is now a far better surgical risk Nutrition has been improved, fluid and electrolyte balance corrected and renal function restored to normal The stomach will have shrunk to its usual size and the gastritis will have subsided, both these changes are conducive to greater ease of surgical manipulation and better postoperative results

Peptic Ulcer

Since surgery is not indicated for nonobstructing duodenal ulcer until medical management has failed, the latter should be attempted first

The basic principles underlying treatment are as follows (1) physical and mental rest, (2) proper diet, (3) neutralization of acid and (4) re education of the patient They are based on a knowledge of the physiologic activities of the stomach and duodenum and on the concept that the ulcer itself is a local manifestation of a general disease

Bed Rest This is applicable to the more severe types of ulcer, namely, all gastric ulcers intractable duodenal ulcers with symptoms of penetration impending perforation or obstruction During the first few days of bed rest, the patient's nervous tension and restless ness may at times seem to increase, but this phase is a temporary one and is succeeded by physical and mental relaxation Lavatory priv ileges are permissible in most cases The bed rest may be continued for a period of ten to twenty days, depending on the nature and the severity of the case

Sedatives The use of sedation is indispensable during the early period of treatment The simplest drug, and notably the best, is phenobarbital (30 mg) three or four times daily at well spaced in tervals The newer modifications of this barbiturate possess no de cided advantages Bromides are a gastric irritant and should be used sparingly if at all They may be necessary in the case of overwrought patients manifesting allergic reactions to barbiturates or idiosyn crasies such as excitement instead of sedation Indications for the use of opiates are exceedingly rare

Antispasmodics The effects of antispasmodics such as belladonna and atropine on gastric motility and secretion, as demonstrated in the experimental laboratory, are not so clearly discernible in clinical medicine Nevertheless, it is current practice to administer antispasmodics in the treatment of peptic ulcer Whatever the drug used, it is to be given in sufficient dosage to secure evidence of physiologic action Tincture of belladonna may be ordered in doses of 14 drops t i d before meals, increasing by one drop daily until the patient experiences uncomfortable dryness in the throat or blurred vision and inability to focus, especially when reading The usual dose of atropine sulfate is 0 4 mg three or four times daily This may be given by hypodermic injection if vomiting is a troublesome symptom The action of the synthetic antispasmodics parallels that of the older drugs and does not appear to be superior when given in comparable dosage, except for possibly fewer side effects

Diet The essential characteristics of all generally accepted feeding regimes are similar in that they consist of soft bland foods served at moderate ranges of temperature, and given in small quantities at frequent intervals (hourly to two hourly) to control the amount of free hydrochloric acid in the stomach Feedings should be given not only throughout the patient's waking day, from early morning until late evening, but also from one to three times during the night, depending on the severity of the case and the secretory activity of the stomach The Sippy diet is a high fat diet designed to depress gastric secretion The Smithies diet is a high carbohydrate diet and the Lenhartz diet a high protein diet All three seem effective in promoting the healing of peptic ulcers In undernourished patients, the addition of supplementary protein feedings for nutritional purposes would seem to be a rational procedure Predigested protein mixtures have a certain amount of neutralizing or buffering action on gastric acid, but they are rather unpalatable and not too well tolerated by many patients Night feedings should be as simple as possible 4 ounces of half and half milk and cream or warm cooked white cereal with milk or cream

Neutralization The level of free hydrochloric acid may be lowered by chemical neutralization and adsorption or by a combination of these two mechanisms Whatever the substance employed, it should be given from one half to one hour after feedings, when the acidity is approaching its height, not merely t i d or p r n for pain The objective is to prevent the acidity from attaining an undesirable level, not to overcome it after a deleterious concentration has been reached

All alkalies are rapidly effective in accomplishing neutralization, but the duration of action is comparatively brief, so that repeated doses are necessary This may result in further stimulation of the acid secretory mechanism, so that a vicious cycle of higher secretion is established In older individuals and in those with renal damage, the kidneys may be unable to excrete the excess base The carbon dioxide combining power of the blood may rise above the normal range and alkalosis will result

Alkaline powders may be compounded to have either laxative or constipating properties (Sippy powders 1 and 2, respectively) so that by varying the relative number of doses of each type, it is possible to regulate the bowels The individual dose of an alkaline powder should not exceed 1 to 1 5 grams

Magnesium trisilicate is less stimulating to gastric secretion and, being poorly absorbed, does not give rise to alkalosis These advantages are counterbalanced by certain disadvantages, such as inferior neutralization and slowness in attaining its full effect The average dose is 2 to 4 grams Individual tolerance to repeated doses varies In some it acts as a mild laxative, in others it produces constipation

The amphoteric substances, such as aluminum hydroxide gels, are nonabsorbable and effective controllers of free acidity They are free of certain undesirable effects, such as secondary hypersecretion or alkalosis, but are markedly constipating in the usual dose of 4 to 8 cc The formation of hard fecal masses with attendant rectal discomfort or the development of fecal impactions is such a frequent occurrence that it is advisable to perform a rectal examination every few days when the patient is confined to bed or otherwise inactive To overcome this inherent disadvantage, combinations of the gels with magnesium trisilicate or mineral oil and milk of magnesia have been used with a partial degree of success Like other anti acids, the gels are given one half to one hour after feedings

Continuous Drip Patients with penetrating lesions or associated severe gastritis may suffer intractable pain or profuse vomiting Under these circumstances a continuous drip through an inlying gastric tube may relieve the symptoms Administration of the drip from 9 P M to 7 A M to control the night secretion is sufficient in most cases A mixture of two parts of milk and one part water is regulated to flow at 40 drops a minute or 200 cc an hour Constant attention is necessary to keep the drip running freely The reservoir must be shaken at intervals of ten to fifteen minutes to prevent sedimentation and the Levin tube must be irrigated with 10 cc of warm tap water several times through the night In obese

patients, a mixture of one part aluminum hydroxide and two or three parts water may be substituted for milk, but the possibility of a resultant rectal impaction must be kept in mind Since a continu ous drip may be disturbing to the patient's rest, it is important to give adequate sedation at bedtime Certain patients cannot tolerate the inlying tube Many of these can be managed quite well by ad ministering three or four small night feedings instead Patients with persistent pain and marked hypersecretion of a strongly acid juice, which cannot be neutralized effectively by the usual methods, may require a continuous day and night drip of diluted milk or gel, in addition to the usual hourly or two hourly small feedings

Aspiration Patients with delayed gastric emptying, whether due to pylorospasm or scarring, are helped by periodic gastric aspira tions and lavage with 1 to 2 per cent sodium bicarbonate solution in warm tap water Aspiration should be done at 8 A M and 10 P M and the amount obtained recorded on a special sheet in the record Pa tients with persistent pain without clinical or x ray evidence of gas tric retention or obstruction will also benefit from such aspiration therapy Aspiration may also be performed at any hour during the day or night, when pain seems to recur rhythmically despite ordi narily adequate treatment The gastric juice should be tested with Congo red paper to ascertain whether free hydrochloric acid is pres ent and whether the neutralization regime is effective

Habits In mild cases the use of tobacco in moderation (from three to six cigarettes daily) may be permitted In long standing cases and those with complications or intractable pain, complete abstinence from tobacco should be required Coffee is a powerful stimulant to gastric secretion and should be allowed only after con valescence is well established and then as a weak brew diluted with milk Alcohol is not to be taken at any time Gum chewing leads to aerophagia and at times to hypersecretion Effervescent beverages are best avoided

Re-education The patient must be impressed with the fact that the peptic ulcer is a local manifestation of a general disease and that since reactivation is a permanent threat, he must learn to live in accordance with certain hygienic rules, much as the patient with diabetes or pulmonary tuberculosis must learn to live with his dis ease A reasonable amount of exercise, a shortened working day, frequent rest periods, periodic vacations, adequate sleep, the avoid ance of minor annoyances and unusual responsibilities form the basis of a well ordered existence The patient should be taught to employ protective measures during expected periods of stress and

during seasons when the incidence of recurrences increases A philosophy of compromise between the dictates of ambition and the realities of partial fulfillment, of calm in the face of aggravation and frustration, will help considerably

Vocational and Social Adjustment For the accomplishment of the foregoing the patient may have to make certain vocational and social adjustments The type of work may be too demanding, the environment (physical or personal) may be too disagreeable, the hours too restricting for the observance of proper dietary and general hygiene Social responsibilities, familial or otherwise, may be unduly oppressive or unfair to the patient At times such readjustments may need psychiatric guidance and support Such guidance should be given by the patient's physician rather than by a psychiatric specialist, unless the psychological background of the illness is a deep seated neurosis

Surgical Treatment

Only a very small percentage of peptic ulcers require surgical management Surgery is indicated (1) If a patient has faithfully followed the type of therapy heretofore outlined and has failed to obtain relief (2) if the ulcer is gastric and a reasonable period (weeks, not months) of medical management has not cured the ulcer, so that it is necessary to assume that the disease may be carcinoma (3) if the ulcer is penetrating and causing intractable pain or has produced more than one severe hemorrhage, especially in people over fifty years of age, (4) if there is recurrent or intractable pyloric obstruction and (5) if the ulcer is prepyloric and therefore likely to be malignant

Except for a pyloric obstruction of long standing associated with occlusion by scar tissue and low acidity, gastro enterostomy is no longer an acceptable procedure

Two procedures now competing for preference are subtotal gastrectomy and bilateral vagotomy The first is a well established procedure with the following limitations (1) Gastrojejunal ulcers will occur in a small percentage, particularly if the gastric acidity is unusually high or an inadequate resection has been performed (2) If a fistula into the colon occurs, rapid and serious malnutrition follows in addition to other symptoms (Marginal ulcers are sometimes difficult to diagnose If 200 cc of tap water put into the fasting stomach is painless, while 200 cc of 0 5 per cent hydrochloric acid produces ulcer distress, the diagnosis is more probable The diagnosis of marginal ulcer is sometimes best made by gastroscopy) (3) Not a

few complain of nausea and postprandial distress due to rapid emptying—"dumping"* Some show nutritional deficiencies

If the ulcer is duodenal and has not been resected, massive post operative hemorrhage may occur Hence resection of the ulcer should be included in the operative procedure, unless the technical hazard is prohibitive

Because of these limitations, bilateral vagotomy has been intro duced on the ground that suppression of psychic secretion is sufficient to allow healing and prevent recurrence This operation may be done transthoracically, but since many cases require local inspection of the diseased area, the vagotomy may be performed subdiaphrag matically, though it is more difficult to locate the main trunks The fibers must be divided about 3 inches above the cardio esophageal orifice, whatever approach is adopted Failure to cure is usually due to failure to section all gastric vagus fibers Complete vagotomy can be demonstrated by a negative insulin test But even with a successful vagotomy, some failures have occurred Transient post-operative gastric retention will require decompression by a tube, or even a gastro enterostomy Parasympathomimetic drugs such as urethane of β methyl choline ("urecholine"), 5 mg t i d orally, are now in use to promote gastric peristalsis in the milder cases of post operative gastric retention The degree and persistence of post operative diarrhea is variable, but it is usually controllable within a few weeks

Postoperative Care This is essentially the same whether gas trectomy is performed for ulcer or neoplasm An inlying Levin tube, placed preoperatively, is attached to suction and serves to empty the stomach of secretion, blood and swallowed air Water is allowed during the first forty eight hours in small quantities, sufficient to moisten the mouth, but not to satisfy thirst The fluid requirement is given entirely parenterally After forty eight hours one ounce of milk and water in equal proportions is allowed every fifteen to thirty minutes until the fourth day Continuous suction is then discon tinued and whole milk is allowed every half hour or so, with the tube clamped The tube is unclamped every few hours and gastric re sidual determined by aspiration If there is a substantial negative gastric fluid balance, suction is reapplied for another twenty four hours and the previous regime repeated This procedure is continued until it is evident that the stomach is propelling its contents caudally

* The symptoms of dumping have been explained as being due to a hypoglycemia following a hyperglycemia which results from uncontrolled rapid flooding of the jejunum with ingested carbohydrate

Morning and evening aspirations are done as a check on this observation and when retention is no longer present in excess of 200 or 300 cc, the tube is removed This can generally be done by the fifth day Feeding thereafter follows an accelerated Sippy regime In the case of resection for carcinoma, the foods allowable may be more varied and in general are those of a soft bland diet

If considerable retention persists for much longer than a week, a technical mechanical defect at the anastomosis or edema due to inflammatory reaction or to nutritional causes may be responsible Cautious fluoroscopy to determine patency may then be required Nutritional balance meanwhile should be sustained as well as possible by parenteral feeding Surgical relief for obstinate retention is occasionally necessary The gross discomfort from an inlying tube can be avoided by placing a tube into the stomach through an enterostomy or gastrostomy wound at the time of resection

The most serious complication of gastrectomy is a *duodenal fistula* This results from insecure closure of the duodenal stump The destructive effects of such a fistula are obvious Peritonitis and death is the usual result Occasionally a local or subphrenic abscess mav form and healing may follow drainage of the abscess (For treatment see chapter on Pancreas)

After *total gastrectomy* for carcinoma, feeding may be entirely parenteral during the first week or by a jejunostomy constructed at the time of operation If jejunostomy feedings are not provided for, the regime for partial gastrectomy is followed at a somewhat slower pace The best guide for feeding is by trial in the individual case If a Levin tube is placed so as to cross the anastomosis, the feeding through it may be as for jejunostomy Usually the tip of the tube is left proximal to the anastomosis and is attached to suction so as to protect the anastomosis against swallowed saliva After solid food can be taken, it is given frequently in small amounts and eventually a six meal regimen is established to avoid overdistention of the proximal jejunum Regurgitation of swallowed food and fluids is not infrequent The possible development of macrocytic anemia requires careful watching

Dietary and drug therapy management following surgical healing is prescribed and continued by the gastro enterologist Frequent feedings are necessary Transient hyperglycemia from the rapid entrance of large amounts of hypertonic glucose into the jejunum, delayed absorption of vitamin A, and excess fecal fat from high fat intake may occur, but there is little more than slight distress after eating The hyperglycemia and delayed vitamin A absorption are

aggravated if pancreatic insufficiency due to partial resection of the pancreas is present Prophylactic liver extract against the development of macrocytic anemia should be given to every patient After successful vagotomy, no special care of the stomach is required and the patient may dispense with all special therapy except for cautious feeding, should there be delayed emptying

Massive Gastro intestinal Hemorrhage

The first task in such patients is to determine the extent of blood loss and to replace it fully as soon as possible Whether the patient is or is not in shock, proceed at once to type and cross match the patient and determine the Rh Obtain as many donors as possible, because even if the bleeding has stopped, it may resume In the unusual event that the blood bank does not have a single appropriate blood available for the first transfusion, begin an infusion of plasma or 8 per cent gelatin Glucose and saline solution are of little value except to correct dehydration, if present, and as a temporary stopgap while waiting to obtain the blood or blood substitute If the bleeding has stopped and the patient is not in shock, a deficiency in blood volume may still exist, though it is not likely to exceed 1000 to 1500 cc A pulse of 80 or less, a normal blood pressure and a warm dry skin suggest that the deficiency is fully made up or nearly so If shock is still present, the deficiency is not made up or the shock is too far advanced to be remediable or it is due to some other cause than the hemorrhage Red counts and hemoglobin determinations are not useful as guides since they will be normal until enough time (twelve to twenty four hours) has elapsed for dilution with extravascular fluid to have occurred

Hesitation to continue replacing blood loss for fear that restoration of a normal blood pressure will activate the bleeding is ill advised The evidence to justify this fear is meager indeed, while the danger from continuing shock is real and dominant

Having instituted the foregoing procedures, consider the type of bleeding in order to identify the location of the hemorrhage Hematemesis places the site of bleeding proximal to the second portion of the duodenum Tarry stools may also occur In the absence of hematemesis, tarry stools usually indicate that the bleeding either is not massive or if massive, that it arises from the small intestine (as from a hemangioma, benign or malignant neoplasm, ulcer in a Meckel's diverticulum, etc) Red blood by rectum in the absence of tarry stools signifies bleeding from the terminal ileum or colon Occasionally, if the bleeding from the stomach or duodenum is profuse

and the gut is hypermotile, liquid red blood may be passed by rectum, but this is likely to be associated with tarry increments of stool

If the bleeding is manifest largely as a hematemesis, a peptic ulcer is by far the most likely cause In about one of eight of such instances of massive hemorrhage the cause is a gastric carcinoma In a still smaller percentage bleeding is from esophageal varices or some other lesion (lymphoma, acute ulcerating gastritis, polyp) A small minority of patients will disclose no recognizable cause for the bleeding either during life or at postmortem examination



Fig 8 Benign leiomyoma of the jejunum 7 inches distal to the ligament of Treitz causing repeated intestinal bleeding (Courtesy of Dr William S Altman)

The following data should be available to help determine whether the bleeding has stopped a chart showing the blood pressure and pulse every half hour frequent notes as to the character of the vomitus and the blood content of the stool and a daily hemoglobin determination

If the bleeding has stopped, measures to establish a diagnosis may then be taken, preferably twenty four to forty eight hours or longer after apparent cessation of bleeding A precise and detailed history and a physical examination are by far the most useful source of data

for this purpose X ray studies, gastroscopy or esophagoscopy may be undertaken, if the diagnosis is obscure, with caution to avoid un due manipulation of the patient or the abdomen so as to reactivate the bleeding If necessary, these studies may be done, even if mild bleeding is still continuing, providing the patient is out of shock

X ray studies and gastroscopy should be avoided if the evidence of the cause of the bleeding is unequivocal (1) if there is hepatic cirrhosis, splenomegaly and leukopenia (Banti's syndrome), (2) if there is a definite history of peptic ulcer, or (3) if there is a history or signs of a blood dyscrasia

If the bleeding persists and the probable cause is known, the next step is to determine whether surgical intervention is required This is not a difficult decision to make if the patient has not become depleted and if the lesion is amenable to surgical correction Thus bleeding from a carcinoma, an ulcer in a Meckel's diverticulum or any identified excisable lesion in the stomach or small intestine is a justifiable cause for immediate operation, because the hazard of con tinued bleeding is great, the likelihood of spontaneous arrest un certain and the need for surgery in any case established If the cause of the bleeding is acute gastritis or a blood dyscrasia, surgery can achieve nothing and is contraindicated

Surgery may prove futile because in some instances no cause for the bleeding will be found, while in others, such as a diffuse ulcer ating gastritis, surgery, short of a total gastrectomy, is inadequate A hemangioma may be the cause of the hemorrhage, but it may be so small as to be difficult or impossible to identify

If bleeding is due to a peptic ulcer the decision whether or not to operate may also be difficult The patient may recover and either never require surgery or require surgical therapy that might be done under more favorable circumstances later The patient who has been in hemorrhagic shock for any significant length of time, even if ap parently fully recovered, is not a good risk and needs considerable time to rebuild his reserves for a major surgical ordeal A patient under forty five with peptic ulcer is likely to stop bleeding so long as transfusions can be supplied to sustain him until hemostasis occurs On the other hand, if there have been previous massive hemorrhages, the likelihood of spontaneous arrest is slimmer with each additional hemorrhage If the patient is over forty five, even a first hemorrhage may prove fatal There is general agreement that so long as the pa tient is in shock, surgery may not be done If the patient is out of shock and bleeding has stopped, surgery is to be done, but preferably at a later date when the patient is fully recovered However, if the

hemorrhage either is a recurrent one in a patient under forty five or a first one in a patient over forty five and especially in the sixth or seventh decades, surgery may be done during the hemorrhage as soon as shock is relieved Unfortunately, in attempting to arrive at a decision whether or not to operate, the unpredictable factors and the exigencies of the individual case often justify hesitation, during which the patient may succumb

In the immediate posthemorrhagic phase, these patients require very close watching Most of them will show an elevation of non protein nitrogen If there has been no renal injury from long continued shock, dehydration, starvation, acidosis or alkalosis, the azotemia is said to be due to the absorption of large amounts of hemoglobin from the intestine

The kind of alimentation these patients should receive is a moot question Complete rest of the gastro intestinal tract to control hemorrhage and to facilitate healing of the eroded surface is said to require withholding all food and fluid orally The assumption that oral feeding contributes to the bleeding is of doubtful validity Pro longed feeding by exclusively parenteral routes, together with the effects of hemorrhage, results in substantial nutritional depletion The benefits of an oral high protein diet to forestall such depletion may more than counterbalance the assumed dangers of oral feeding The choice of route for feeding in any case cannot be rigid or ex clusive, since the individual's special circumstances (age, nausea, amount of sedation or opiates needed, the renal and cardiac status, tolerance to intubation, the nutritional reserves of the patient and the type of lesion involved) make it essential to adopt a flexible therapeutic program The morale of the patient, his physical strength and speed of convalescence are probably best served by oral feeding every two hours while awake, using second and third stage Sippy diets In the case of peptic ulcer, withholding of food does not pre vent psychic secretion of acid, which will continue to erode the ulcer Continuous neutralization by a constant drip of milk or amphoteric substances would prevent this, but in that case rest of the bleeding area is not greater than is the case with frequent feedings of a high protein diet together with intervening neutralization therapy

Local treatment includes (1) neutralization therapy in the case of ulcer, (2) drugs calculated to put the gut at rest—opiates, which in crease tonus at first and then decrease it—and atropine sulfate, which, to be effective must achieve a full antiparasympathetic effect Two or three thousand units of thrombin instilled into the stomach every few hours may be useful as a hemostatic agent

Along with the local treatment, psychic and physical rest are essential Parenteral barbiturates, reassurance and frequent observation are required

For residual anemia intramuscular or oral iron ammonium citrate and folic acid are administered

Intestinal Obstruction

The common locations of obstruction are the pylorus from duodenal ulcer or neoplasm of the stomach, any point in the small bowel from tumor, inflammatory reaction, operative procedure or incarceration in hernia and any part of the colon from tumor

It is of paramount importance *to distinguish between simple obstruction and strangulation* (devitalization of the bowel from vascular disorder), because nonsurgical decompressive measures are not sufficient in strangulation, which demands immediate surgery Strangulation is indicated by a rising temperature and pulse, a considerably elevated white blood count (not specific, however), tenderness and *continuous pain* in the region of the strangulation—signs which are absent in simple uncomplicated obstruction Blood in a peritoneal tap is likely evidence of strangulation If loss of blood into the strangulated loop becomes considerable, shock may develop for this reason alone

The pathology of intestinal obstruction has two aspects (1) the local disturbance and (2) its effect upon fluid and electrolyte balance The local disorder consists of an increase in intraluminal tension above the obstruction, which causes progressive proximal dilatation so long as gas and fluid are propelled downward toward the block

Colic is evidence of ineffective forward peristalsis against the block and is always felt in the midline—periumbilical in the case of the small bowel and below the umbilicus in the case of the large bowel This localization of the pain is one way in which intestinal colic is distinguished from gallbladder or renal colic Nausea and vomiting are evidence of reverse peristalsis The veins in the distended gut wall become engorged and edema occurs Unrelieved, the nutrition of the wall may be impaired so as to allow ulceration or even necrosis, particularly in high grade distention of the cecum Peritoneal contamination from intra intestinal organisms can occur without necrosis, though usually only a free fluid transudate will be found The great increase in bacterial flora in these circumstances threatens intestinal viability Antibiotics, especially penicillin parenterally and streptomycin by mouth (1/4 gram q i d), may minimize their effects so that even partially devascularized loops may recover

The constipation of intestinal obstruction will not become evident until evacuation of all fecal content present below the obstruction Therefore, one must not insist on this sign in all cases There are numerous instances of diarrhea, at least loose stools, in the presence of obstruction, either because of a "weeping bowel" adjacent to a pelvic abscess obstructing a loop higher up or because of occasional successful negotiation of block (especially if extrinsic, as from a kink) by forceful peristaltic waves

Obstruction of the pylorus, unless due to transitory edema, requires surgical relief, but the urgency is not nearly as great as it is elsewhere in the gut because the local effect, gastric dilatation, and the constitutional effect, loss of gastric juice, for a considerable number of days can be reasonably well met by intubation and by fluid and electrolyte therapy However, inordinate delay will so deplete the nutritional reserves as to increase operative risk and compromise wound healing If the stomach is grossly dilated, several days on constant drainage to shrink the musculature and restore its tone, if atonic, is usually desirable But one should not wait for restoration to normal gastric size

Strangulation requires immediate operation regardless of the duration of the disorder

Acute nonstrangulating obstruction of the small intestine also should be operated on at once if it is of not more than twenty four hours' duration But if there is high grade distention, or the patient is of advanced age or the obstruction is more than forty eight hours old and the patient severely depleted, operation is delayed These patients have a reduced blood volume in addition to severe fluid and electrolyte deficiency They may be on the verge of shock, if not in shock Moreover, surgical decompression of the distended soggy bowel wall is hazardous (postdecompression engorgement), sutures may not hold and the discrepancy in lumen size between distended and normal wall below may make an anastomotic procedure difficult It is far better to utilize decompression by intubation and suction, if it can be achieved with reasonable speed, whether surgery is or is not required subsequently, provided blood volume and fluid and electrolyte deficiency are corrected meanwhile

Gallstone ileus should be suspected in patients with a history of long standing chronic cholecystitis This is a fulminating and often fatal form of small bowel obstruction If suspected the abdominal x ray film on careful examination may disclose the stone impacted in the lower ileum Surgical interference may be required sooner in this condition than in other types of nonstrangulating obstruction

Whether the obstruction is or is not relieved, surgery should be done as soon as the physiologic status of the patient is sufficiently good to allow recovery from the surgical trauma If decompression by the tube is not effective in relieving the obstruction within a reasonable time, intervention should not be delayed unduly If the distention is high grade or the patient is in poor condition, do an enterostomy without attempting to release the obstruction The tube assists in quick identification of the site of obstruction at the time of operation Whether resection is or is not performed, it is left in place postoperatively until peristaltic function is restored

Large bowel obstruction is a closed loop obstruction because the ileocecal valve usually prevents backward decompression Super imposed edema or a fecal mass often completes an incomplete ob struction, so that early efforts to decompress by several enemas may succeed in reopening the passageway If they do not, intubation cannot be relied upon for lack of time and surgical decompression is needed It is far better, for lesions of the left half of the colon, to do a transverse colostomy than a cecostomy, which is not so effective for sidetracking the fecal stream, even if it is effective to relieve tension, unless the cecum is fully exteriorized

If the obstruction is incomplete and relief is not urgently needed, streptomycin (1/4 gram q i d for two days) or sulfathalidine (3 grams t i d for four days) may be given by mouth to reduce the bacterial count prior to surgery A few cleansing enemas may be given and the diet should be a high protein nonresidue liquid diet Laxatives or cathartics preoperatively are best avoided

Preoperative Preparation

When obstruction is suspected, a "scout" film of the abdomen is taken to observe the gas pattern of the gut Pyloric obstruction will outline the gastric fundus or a larger area of gastric wall, depending on the amount of fluid and gas present Small bowel distention will show a variable pattern of gas shadows, which are distinguishable from a large bowel pattern and may, by their distribution, permit an approximate localization of the block In large bowel obstruction the cecum or proximal half of the colon generally shows the highest degree of dilatation Localization of the block on the basis of the gas pattern is more accurate in the large than in the small bowel If the x ray film is inconclusive, a barium enema will usually estab lish the site of involvement in obstruction of the colon Paralytic ileus will show gaseous distention of the large and small bowel

A bismuth meal is never employed in acute intestinal obstruction Determine the hemoglobin and in severe dehydration, the hematocrit It is unnecessary to determine the blood nonprotein nitrogen or sodium chloride The former will be elevated in dehydration and the electrolyte therapy will be the same whether the sodium chloride is near or well below the normal level

Begin intravenous fluid and electrolyte therapy at once (See chapter on Fluid and Electrolyte Balance) If depletion is severe, plasma or, better, whole blood may be required in addition, whether or not shock is present or impending

Begin chemotherapy Penicillin and streptomycin are given parenterally in advanced cases If vomiting is absent and the patient can retain some fluid, streptomycin or sulfathalidine or both may be given orally for local bacteriostasis and in anticipation of a surgical attack on the lesion If intubation with suction is employed this is not done

If strangulation or high grade closed loop obstruction (volvulus of sigmoid) is suspected and immediate surgery is required, lavage the stomach, empty it and leave the tube in If surgery is not imminent, do the same, employing a Miller Abbott or Harris tube and apply suction If conservative treatment is to continue, feed the tube as directed in the chapter on Clinical Procedures Patients who resist intubation as a rule can be persuaded to cooperate Children, very old, disoriented, frightened or actively nauseated patients will be troublesome If reasonable persistence fails and some hours without progress have gone by and the obstruction, of whatever variety except pyloric obstruction, is high grade, surgery should be performed without further delay

Intestinal Fistula

A duodenal or upper intestinal fistula is a catastrophe because of the rapid depletion from profuse loss of fluid The fluid and electrolyte and nutritional problem is a formidable one Surgical correction, if possible, should be done with the least delay The digestive enzymes, which erode the skin, require the local application of antitryptic substances, such as powdered aluminum in an ointment base, copper bronze powder, tincture of benzoin or, best of all, ground meat Constant suction applied to the fistula is helpful

Regional Enterocolitis

Regional enterocolitis occurs chiefly in adolescence and among young adults, beginning with a general indisposition and vague ab

dominal discomfort, localizing eventually in the right lower quadrant and simulating a low grade appendicitis or mesenteric adenitis Appendectomy, frequently performed in error, is occasionally followed by a fistula in the scar Diarrhea without melena is nearly always present Progressive loss of weight, malnutrition, anemia and vitamin deficiency set in Occasionally an intractable fistula in ano results Recurrent colic, usually of mild intensity, is common While the disease, as a rule, involves only the terminal ileum, it may involve the cecum or more distal parts of the colon or it may spread to the



Fig 9 Regional ileitis Observe the narrowed lumen of the terminal ileum in the barium enema

proximal small gut either by contiguous spread or with skip areas intervening Fistulas between loops or between gut and other viscera may develop

A tender mass is frequently felt in the right lower quadrant, but x ray examination often provides the definitive diagnosis by the finding of delayed emptying of the ileum, a narrowed ileal lumen (string sign) and spasticity of neighboring intestinal muscle

If the disease is in its very early stages, operation is not indicated, since many instances of spontaneous resolution occur If the disability is considerable and does not yield to medical therapy, ileo

transverse colostomy alone may be curative, but regional resection may be required subsequently Recurrences, even years later, in spite of massive and apparently adequate resection, are not uncommon Chronic ill health is likely in spite of surgery in many patients Preoperative and postoperative care is as for resection of the colon

THE COLON

Ulcerative Colitis

This disease, like regional enterocolitis, is complicated by the development of severe nutritional deficiencies, with resulting loss of resistance to infection, and the frequent occurence of an obstinate fistula in ano Extreme wasting, pyodermias and joint disorders occur in advanced cases Not a few patients die of spontaneous perforation of the colon or from massive hemorrhage

Many of these patients show a strong psychic disorder or considerable emotional instability, so that the disease is widely regarded as a psychosomatic disturbance Inspection of the colonic mucosa during emotional stress is said to reflect the same vascular responses which have been observed in patients with a gastric fistula Whether the organic disease is directly induced by psychic maladjustments or not, it is clear that the latter almost inevitably will be acquired because of the destructive effects of the disease upon every sphere of the patient's life—so that the therapeutic program should include psychiatric evaluation and therapy Intestinal disinfection with massive parenteral and oral chemotherapy is often followed by long remissions Supportive therapy with transfusions will also be helpful Because of diarrhea, the synthesis and absorption of vitamin K may be deficient A resulting reduced prothrombin production may aggravate the bleeding Hence all patients should receive vitamin K, preferably parenterally during periods of diarrhea

The surgeon is seldom asked to intervene until the condition is well advanced This is understandable in view of the cyclic character of the disease and the mutilating results of ileostomy, whether or not subsequent colectomy, which is frequently necessary, is performed Some patients adjust well to ileostomy, occasionally a patient is driven to suicide But hesitation to do an ileostomy when rapid deterioration is taking place may result in death The mortality statistics of ileostomy (30 per cent in late cases 4 per cent in early cases) are in no small measure due to the fact that the surgeon is too often asked to deal with patients who are nearly moribund either from advanced general deterioration or from sepsis due to perforation or from shock due to hemorrhage When ileostomy is performed, it

often, but by no means always, produces a dramatic remission Restoration of bowel continuity is rarely compatible with sustained arrest of the disorder On the contrary, colectomy is frequently necessary to eliminate alarming or persisting hemorrhage, diarrhea and chronic invalidism Moreover, some 15 per cent develop carcinoma in the remaining colon or rectum

Recently, vagotomy for this disease and for regional enteritis has been attempted because of the slowed up transit of small and large bowel content which vagotomy is said to produce * Extended observations will be required to assess the validity of this technic, which, if justified by experience, would deservedly supplant ileostomy or colectomy

Preoperative preparation is symptomatic Transfusions are given to provide a normal blood volume and red cell count Nutrition should be sustained as far as possible Massive parenteral chemotherapy is given before and after operation The anesthetic may be general (cyclopropane) or regional or both A tube is generally inserted into the well exteriorized loop It is necessary to see that the tube does not clog The incision should not be disturbed during manipulation of the tube

Enterostomy for ulcerative colitis is, as a rule, a manageable form of fistula because it is done low in the ileum The application of tincture of benzoin or "skin cement" many times a day, from the day of operation onward, to provide a thick protective coating against enzyme action, is worth while until the skin becomes resistant or the enzyme content less active If fluid loss is excessive, regard should be had for the degree of fluid and electrolyte depletion, and treatment given accordingly

Another troublesome complication is prolapse of the loop The prevention or correction of this complication is as yet an unsolved technical problem To obviate skin erosion and prolapse, a recently devised modification of the ileostomy procedure provides for covering the exteriorized loop of ileum with a split thickness skin graft so as to resemble a penis, which projects well beyond the skin into a suitable receptacle †

In the early postoperative period the best apparatus to use is the "Travellor" bag, with replaceable latex containers After healing and shrinkage of the loop, this bag is replaced by the Koenig Rutzen bag, which is a simple convenient bag that is cemented to the skin

* Dennis C and Eddy F Vagotomy in Ulcerative Colitis and Regional Ileitis Annals of Surgery 1948 in press

† Dragstedt L R Dack G M and Kirsner J B Annals of Surgery *114* 653 1941

Carcinoma of Colon

The barium enema is the most valuable single test for diagnosis and localization of large bowel lesions

Do not give barium by mouth if there is a possibility of obstruction Use a barium enema only if necessary and preferably in a thin mixture There is seldom need for a barium enema if one can palpate a rectal or rectosigmoid carcinoma or see it through a proctoscope Over 90 per cent of rectal or rectosigmoid lesions can be felt with the finger or seen with the sigmoidoscope If a barium enema is performed, the barium should not be allowed to pass the site of obstruction, except in the rare circumstance when multiple lesions are suspected, as in polyposis with carcinomatous degeneration

So long as the lesion has not extended to involve the peritoneum either by direct extension or by perforation with abscess formation, pain will be due to obstruction, i e , it will be colicky and will be located across the lower abdomen, regardless of the site of disease Lesions low in the rectum may cause local discomfort (tenesmus, and the like) in addition

It is common practice to utilize the proctoscope or sigmoidoscope for the diagnosis of lesions of the rectum and sigmoid (See chapter on Clinical Procedures for technic) There is no doubt as to the value of this procedure for inspection of the mucosa in conditions such as ulcerative colitis, amebiasis, polyposis, etc , and for carcinoma of the sigmoid If this and x ray study are inconclusive and the lesion is of doubtful character, biopsy may be taken If the lesion is obviously a carcinoma, biopsy should be avoided because perforation may result If the lesion is a polyp on a narrow pedicle, it should be removed by a snare with fulguration of the base by a high frequency current Broad based polyps are likely to be malignant The base must be excised and examined and, therefore, not fulgurated

If there is obstruction of the sigmoid, with stools consistently negative for blood, diverticulitis is a likely possibility The serrated outline of the inflamed spastic canal in the barium enema films will be diagnostic In occasional instances a roentgenographic distinction between an obstructing carcinoma and acute diverticulitis may not be possible Even a palpable mass may not help to differentiate Fever, leukocytosis, previous attacks of "left sided appendicitis" suggest diverticulitis Blood by rectum is far more likely to be due to carcinoma Acute diverticulitis is a nonsurgical disorder unless there is a frank abscess or a complicating peritonitis The palpable mass shrinks under conservative therapy combined with antibiotics In occasional instances of obstinate acute diverticulitis, transverse

colostomy will assist in resolution of the process Chronic recurrent diverticulitis is sometimes effectively eradicated by resection

Lesions above the sigmoid cannot be localized without roentgen ography unless the pain of peritoneal involvement is present or a mass is palpable The mass may not be palpable because the patient is too fat or the site is inaccessible, e g, the splenic flexure Bleeding may be, but seldom is, massive Obstruction is late and uncommon in lesions of the ascending colon because the fecal stream is liquid in this region Frequently a mass in the ascending colon is readily palpable Anemia is likely to be pronounced in right colon lesions

Decompression before operation by the tube method is seldom in dicated even if the small bowel is greatly distended with gas or over loaded with fluids Surgical decompression of the proximal colon will relieve both the colon and the small intestine High grade ten sion in the colon requires relief sooner than tube decompression can achieve it

Hence, when obstruction is complete and is accompanied by proxi mal distention, transverse colostomy or cecostomy is usually neces sary, but resection must be delayed for a second stage procedure Nevertheless, a preliminary effort to decompress the bowel by enema should be made in all patients Success may obviate a two stage procedure Meanwhile, if time allows, i e, if the distention is relieved or of minimal degree, the patient is prepared by intestinal chemo therapy—streptomycin, 1/4 gram t i d orally, or sulfathalidine, 3 grams t i d The remarkable cleansing these drugs achieve by bacterial depopulation adds substantially to the safety of the subse quent operative procedure If only partial relief is obtained, cautious additional clearing with small doses of mild cathartics may be at- tempted, although this is preferably avoided altogether If these measures are ineffective, a first stage decompressing colostomy prior to resection is unavoidable because the distended edematous proxi mal bowel is unsuitable for constructing a safe anastomosis

If the obstruction is not associated with proximal distention, four days or more should be allowed for effective preoperative prepara tion Maximal benefit from oral chemotherapy requires not less than three days, while other measures, such as enemas, nutritional, vita min and fluid therapy and transfusions may require even more The preoperative diet should be a nonresidue diet, with liquids only on the day before operation Enemas should not be given later than twenty four hours prior to surgery in order to provide a "dry" intes tine at operation An inlying urethral catheter is introduced the morning of operation, if the rectum is to be excised

Postoperative Care

When resection and anastomosis is performed, a colostomy or cecostomy proximal to the anastomosis or the Levin or Miller Abbott tube is indicated to keep the bowel proximal to the anastomosis de compressed The choice of procedure depends on the degree of dis tention of the bowel at the time of operation

If bowel is exteriorized, it is seldom necessary to leave it obstructed in order to avoid wound contamination To do so and attempt to obviate distention by a Levin or Miller Abbott tube is to inflict un necessary suffering A large tube, tied into the bowel immediately after operation, will allow the escape of gas and feces during the time needed to allow sealing of the wound edges The latter may be protected by "skin cement," while petrolatum gauze is used to cover the ex posed serosal surfaces

Enemas should not be given after performing an anastomosis Cleansing below the anastomosis is not required and is hazardous Evacuation of the proximal loop will occur spontaneously As soon as flatus passes it is evident that the stoma is patent A stool may be expected within a day or two Thereafter, if evacuation is inade quate, small volume enemas may be useful The diet is a liquid diet for the first forty eight hours and thereafter a nonresidue soft solid diet is given As soon as bowel function is adequate, a normal diet is allowed

Following abdominoperineal resection, the posterior pack should be removed in stages, beginning about the fourth day and finishing in a day or two The granulating cavity that is left needs only ex ternal cleansing It may require several months to heal completely

Parenteral chemotherapy is given to avoid postoperative sepsis locally and in the lungs and, if the patient is on catheter drainage, to control urinary sepsis The catheter is removed in about a week but the residual urine after voiding should not exceed 2 ounces If cath eterization shows a larger residual, it may have to be reinserted for a longer period of constant drainage

Restoration of continuity is generally possible for all but low sig moid or rectal lesions The recent vogue of resection with end to end anastomosis for all but the lowest lesions of the rectum, in order to avoid a colostomy can be justified in the case of those whose life expectancy is likely to be short whether because of age, other disease or metastases A radical cure by this procedure is less likely than by the abdominoperineal procedure because it cannot extirpate as large a part of the adjacent mesenteric lymph node system Other lesions distal to the mid colic artery are treated by resection and

end to end anastomosis, providing the proximal bowel is not edema tous, friable or overdistended If it is, a lateral anastomosis is safer Lesions of the ascending colon require hemicolectomy and ileotrans verse colostomy

Colostomies, particularly left sided ones, do not present a seri ous problem in skin care or fluid loss Patience and studied control of the diet of the individual will be rewarded after a period of time with bowel control that allows the patient to continue normal activi ties Somewhat constipating diets are needed in most individuals A gentle enema of saline once a day or every other day will establish regularity eventually and reduce intervening soiling Insertion of tubes into colostomies should be done with great care because of the danger of perforation of bowel Marked difficulty in fecal discharge suggests stenosis of the orifice by scar contraction The patient should be shown how to dilate the orifice gently if it is too tight A good abdominal support surrounding the protruding bowel may be needed in those who have an accompanying muscular dehiscence

Instructions for Patients with Colostomy

General Considerations A patient may live comfortably, hap pily and inoffensively with a colostomy, carrying on his (or her) usual occupation without inconvenience, if he will learn how to regulate the bowel This end can be attained with rare exceptions The following instructions should be given in pamphlet form to all patients Those who cannot read and understand it need special instruction

Diet One principle upon which the satisfactory management of a colostomy depends is that the bowel must be kept so constipated that it will not move without the use of an enema This is not det rimental to health and many patients learn that they can use an enema every other day or even every third day without suffering any illness or gross discomfiture as a result In the majority of cases a return to one's customary dietary habits is quite consistent with satisfactory function of the colostomy Some patients find it neces sary to avoid certain articles of diet which have a laxative effect upon them A few patients will always have to adhere to a constipat- ing diet in order to avoid soiling themselves between enemas Such foods as fresh fruits and green vegetables, especially cabbage, lettuce, celery, string beans, turnips and others of a fibrous nature, bran, coarse cereals and coarse breads, fruit juices, prunes and figs, are known to have a laxative effect and should be avoided in cases where the bowel tends to move between enemas Foods such as milk, re fined cereals (cream of wheat, etc), cheese, fish, most meats, white

bread, potatoes, macaroni, rice, and all others having little or no indigestible residue tend to have a constipating effect In any event, each patient must learn for himself what he can eat and what things he must avoid

The Colostomy Enema The patient can and should learn to administer his own enema If the bowel is kept constipated by the avoidance of laxative foods and cathartic or laxative medicines, it will be slow to move without the use of an enema If this is done at regular intervals of time there should be no further trouble with the bowel

Frequency of Administration Many persons find it necessary to take an enema daily in order to avoid spontaneous bowel evacuations A large number go as long as three days without soiling The proper interval between enemas must be worked out for each individual by trial It is well to begin with an enema every day, gradually increasing the interval as the bowels become regulated and the contents more solid

Time of Day The enema can be taken at any time to suit the convenience of the patient, but a definite time must be decided upon and always adhered to in order to secure the best results

Equipment Needed

1 An ordinary 2 quart enema can or douche bag
2 Several feet of rubber connecting tubing with a shut off clip
3 A No 24 or No 26 French rubber catheter
4 Warm water with or without the addition of a level tablespoonful of salt

Procedure With the irrigating can or bag hung at a convenient level, the end of the rubber catheter is greased with petrolatum and inserted 6 to 10 inches into the opening If it does not go in easily at first, it may after waiting a few seconds or if a little solution is allowed to run in while the catheter is being inserted The water is then allowed to run in slowly so as to avoid rapid distention of the bowel, which may result in pain The shut off is used to control the rate of flow When enough has been put in, the catheter is withdrawn and the bowel allowed to evacuate

There are many satisfactory ways to handle the evacuation from the bowel With the patient in the sitting posture, a pail or large basin may be held under the opening in such a way as to catch the discharge A satisfactory way is to obtain a piece of rubber sheeting from which an apron is made by attaching tapes to the top so as to hold it tightly about the waist beside the open toilet The free end of the sheet can be put into the hopper in such a way as to make a

trough to carry off the discharge, thus avoiding the use of the basin Many variations of this method, using pieces of inner tube and similar equipment, may be devised An excellent and convenient device called a "Colostigator," which provides all the necessary equipment, may be purchased

It is usually necessary to allow one half to three quarters of an hour for the complete evacuation of the bowel Occasionally there is a little delay After the enema is finished, a small gauze pad may be applied and held with a band

Use of Colostomy Dome If the bowels are kept constipated and moved only by enemas, a colostomy dome is not needed, although a few persons prefer to wear one until they gain confidence enough to go without it

Common Difficulties and Their Remedy

Pain during the Enema This is usually caused by too rapid filling of the bowel or the injection of too much fluid Occasionally soap suds solution will cause cramps when plain warm water will not

Delayed Evacuation If the enema seems to be too slow in returning one may try using soap suds instead of water and salt or in case suds have been used, try plain water or plain water and salt

Inability to Secure Sufficient Results from the Enema This is usually the result of failure to use sufficient fluid In some cases it may result from the bowel content becoming too firm In this event it is well to take small doses of mineral oil until the movements have become soft enough This is the one exception to the rule against laxatives

Evacuations between Enemas This may be because the enemas are not taken regularly enough or because they have not been thorough enough to empty the bowel each time In rare cases an individual may normally have an irritable bowel with habitually two or three movements a day This tendency may persist after colostomy Much can be done by eating a strict constipating diet (see above) In all such cases, however, a regular enema should be administered daily and, if necessary, a dome worn in the intervals This will insure a minimum of annoyance

Bleeding or Mucous Discharge from the Colostomy One often sees small amounts of blood on the gauze used over the colostomy This is not unusual and is the result of the irritation of the sensitive mucous membrane It can be disregarded A certain amount of mucous discharge from the colostomy is normal

The embarrassment from inability to control flatus can be obviated in large degree by the regular consumption of charcoal tablets

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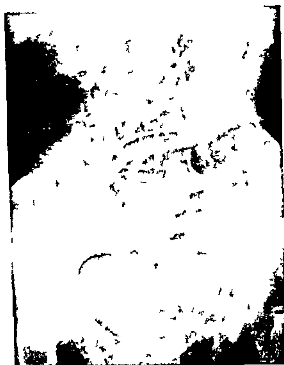


Fig 10 Mechanical obstruction of small intestine due to a gallstone (see arrow (Fine Hurwitz and Mark Annals of Surgery Vol 112)

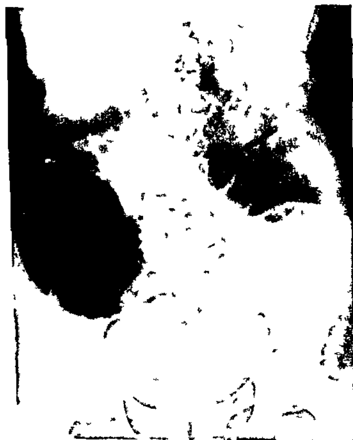


Fig 11 Obstructing carcinoma of the sigmoid Note enormous distention of proximal colon and absence of gas below the descending colon

CHAPTER 16

ACUTE ABDOMINAL DISORDERS

Roentgenography in Acute Abdominal Disorders

The diagnosis of abdominal disorders can be greatly facilitated by simple x ray films in the erect, supine and right and left lateral positions Such films disclose gas, distention and fluid levels in the gastro intestinal tract, gas or fluid in the peritoneal cavity, dis placements or distortion of viscera including the diaphragm, and foreign bodies

Gas in the colon and stomach is a common and normal finding Gas in the small intestine is less frequent but is likely to be seen in pneu monia, asthmatic seizures, gastro enteritis Gas in the small intes tine signifies nothing more than transient stasis so long as the diam eter of the gut is within normal limits The distinction between pathologic dilatation of the small intestine and colon is made by considering the normal location of the various segments of distended gut, by identifying the haustral markings of the colon and the trans verse white lines of the mucous membrane of the small intestine But the serrations of the proximal dilated small intestine are not present in the lower ileum, so that the dilated ileum may be indistinguish able from a distended sigmoid, which is in the same location

Generalized distention of the entire gut is almost always the re sult of paralytic ileus Generalized distention of the small bowel alone is the result of mechanical obstruction If so, there are likely to be fluid levels and the contour of the gut wall is "dynamic," i e , angulated in places rather than atonic or smoothly rounded In obstruction the loops tend to be higher up in the abdomen The loops arrange themselves in ladder fashion or display gas pockets occupy ing abnormal and fairly constant positions, such as gas and fluid levels in the pelvis from fixation by adhesions due to peritonitis A localized gross distention of one or two loops suggests obstruction with strangulation A fixed position of these few loops, with fluid be tween them and much fluid within them giving a "coffee bean" ap pearance, is strongly suggestive of strangulation

Gross distention of the colon alone with symptoms of obstruc tion means obstruction of the colon No gas will be present below the

is permissible in obstruction of the colon, but if the obstruction is not complete, the barium should not be allowed to move proximal to the block

Rupture of the urinary tract can be detected by diodrast extravasation during intravenous urography or by pneumoperitoneum during cystography

Eighty five to ninety per cent of all ureteral stones can be recognized on a "scout film"

In intussusception the barium enema will reveal a shadow resembling multiple rings partly filled with gas and partly surrounded with barium at the site of projection of the intussuscipiens

In severe small bowel obstruction of rapidly mounting intensity a gallstone should be looked for somewhere in the ileum In such patients an air filled biliary tree may be observed

When, during decompression of the obstructed gut by a Miller-Abbott tube and suction, there is a persistence of localized gas filled loops of small bowel, closed loop obstruction due to strangulation should be suspected The relief of small bowel obstruction during decompression by a tube is often revealed by the appearance for the first time of air in the large bowel

In cases where the diagnosis is in doubt, repeated films may be helpful to establish the diagnosis

Ruptured Peptic Ulcer

There is sudden violent midline epigastric pain, continuous without letup for hours Nausea is present, vomiting may or may not be present There is a history of ulcer usually, occasionally none can be obtained The patient is unable to move, the belly is held motionless, the respiration is thoracic Pain spreads radially, usually to the right and occasionally to the left upper quadrant The belly wall is rigid and acutely tender throughout, especially in or to the right of the epigastrium Rebound tenderness is marked Air under the diaphragm is frequently present (x ray) No fever occurs in the first six hours The leukocyte count is normal at first, but rises rapidly after six hours

Preoperative Preparation Aspirate the stomach if this is easily performed with the patient's cooperation Operative closure of the rupture must be done as soon as possible Resection is only occasionally performed because the friable edematous tissue makes safe closure of the duodenal stump difficult

Postoperative Therapy An inlying Levin tube is used to keep the stomach empty and to prevent swallowed air from gathering

site of block In volvulus of the sigmoid, fluid levels and gas in one huge bubble are likely to be seen A barium enema to show the characteristic twisting of mucous membrane will affirm the diagnosis

The peritoneal and visceral markings may be obliterated by fluid or exudate Thus the kidney and psoas muscle outlines are obliterated by the edema of a perinephritic abscess and the parietal peritoneal marking in the right flank by an appendiceal abscess Separation of loops of bowel by fluid may be recognized and pneumoperitoneum from rupture of a gas filled viscus is easily recognized by finding air under the diaphragm, shifting with change in position Gas in an abscess may also be identified by its encapsulated appearance Free gas

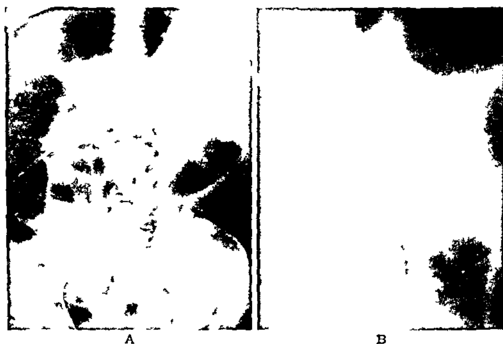


Fig 12 A Volvulus of the sigmoid B The same Note the diagnostic twist of the mucous membrane by barium enema

postoperatively is most likely due to air introduced at laparotomy Constant gas shadows in the right upper quadrant showing a pattern simulating the biliary tree signifies a fistula of the biliary tract

Displacement of the stomach upward suggests a pancreatic cyst or abscess, downward, fluid or blood beneath the eft side of the diaphragm or a mass in or beneath the left lobe of the liver Displacement upward of small intestine suggests a pelvic tumor or abscess or an ovarian cyst An immobile diaphragm seen by fluoroscopy indicates fluid or inflammation nearby

Bismuth by mouth should be avoided in acute abdominal conditions possibly involving the gastro intestinal tract A barium enema

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Sips of water are allowed from the first day No food by mouth is given for two to four days Then a Sippy diet follows in stages and finally medical ulcer therapy is prescribed

Acute Pancreatitis

(See chapter on the Pancreas)

There is severe continuous epigastric pain, radiating to the left or right or both, usually more to the left There is midback pain at the upper lumbar level Nausea and vomiting are profuse Marked sympathicotonia prevails (pale, sweaty skin, rapid pulse, slightly bluish mucous membranes), giving way in fulminating cases to the classic picture of secondary shock The belly is rigid in the epigastrium and right or left hypochondrium Constipation is marked There is gradual or rapid gaseous distention There may be slight icterus Fever is high to absent, the white count is elevated The blood calcium may be so low as to cause tetany The past history is negative or there is a history of similar but milder episodes with or without a history of biliary tract disease Microscopic study of aspirated peritoneal fluid may be diagnostic

Procedure The blood lipase may be elevated, but this test is not as simple nor as practical as the blood amylase test The latter test to confirm the diagnosis is reliable only if done within the first forty eight to seventy two hours (Urinary diastase remains elevated somewhat longer) If positive in a range of 200 units and if the symptoms are of mild intensity, no operative intervention is indicated If positive in a range of 2000 units and symptoms suggest a hemorrhagic or necrotizing process, immediate operation for drainage and relief of tension is advisable The mortality is high

Preoperative Preparation Restore fluid balance and give morphine in adequate dosage Type and cross match for transfusion A Levin tube is optional, but preferable

Postoperative care is symptomatic Blood and intravenous fluids in large volume may be needed Prophylactic chemotherapy may be advisable During convalescence, which is likely to be prolonged, study the glucose tolerance curves for development of diabetes An abscess or cyst may develop

Acute Appendicitis

The pain is periumbilical or epigastric and shifts to the right lower quadrant It is the initial symptom Nausea and rarely vomiting appear later, almost never before pain *If this order of symptoms is not present, the evidence is against this diagnosis* Similar

episodes in the past are not uncommon The pain is continuous, even if variable in intensity Tenderness is always present and usually at the site of pain, though occasionally not, as when the appendix is in an ectopic position, such as in the flank or low in the pelv s The classical case shows rebound and percussion tenderness at or near McBurney's point Pain on hyperextension of the right thigh and rectal tenderness are not consistent findings The white count as a rule is above 10,000 The fever is slight If fever is 39° C or higher, suspect some other disease or a complicating spreading peritonitis Constipation is usual If there is diarrhea, suspect some other dis ease unless a pelvic abscess has already formed

Confusing conditions simulating appendicitis are early regional ileitis, especially if there is a palpable mass which may be an abscess or an edematous inflamed loop of ileum, acute mesenteric adenitis, pyelitis or renal colic, right sided pleuritis (in children), rheumatic fever or acute gastro enteritis In *gastro-enteritis* the pain is seldom continuous or sharply and persistently localized to any one area Ten derness is variable and inconstant Spasm is rare except perhaps during the colicky seizure Fever is not common and nausea often precedes the onset of pain

Special preoperative preparation none, unless there is de hydration or spreading infection *Special postoperative care* none, unless there is peritonitis In that case, give penicillin and strepto mycin, especially if the infecting organism is anaerobic

Acute Salpingitis

There is a history of recent exposure—two days or more—with or without a history of pelvic inflammation The onset frequently is just after catamenia Nausea and vomiting are common Pain is usually low in the midline and bilateral Tenderness by rectum or vagina is always bilateral, especially on motion of the cervix A purulent or mucopurulent discharge from the cervix is present and should be cultured and smeared for the gonococcus Dysuria may be present or absent Spasm is present on both sides usually Distention is present or absent Fever is 101° F or higher The white count is al ways elevated *Treatment* penicillin

Peritonitis

Except in old or debilitated patients, fever is always present Pain is severe or moderate Spasm and tenderness are localized or general ized Distention is progressive Rebound tenderness is present The white count is above 10,000 Sympathicotonia increases as toxemia

advances Constipation is usual A "scout" film shows dilated intestinal loops Anorexia, nausea and vomiting are variable Shock appears in advanced cases

If the type of infection is not known or if the diagnosis is in doubt, needling of the peritoneal cavity at the suspected site is a useful and safe procedure, in spite of a common impression to the contrary, except perhaps in extreme distention Even if the yield is only in the needle shaft, it is enough for microscopic diagnosis This procedure is useful in infants or where the history and physical examination are not conclusive

Nonoperative Therapy To minimize distention introduce a Miller Abbott tube with or without suction, depending on the amount of fluid and gas being recovered No peroral fluids or food are given, but parenteral fluids are given as indicated No drugs are used for distention, except 100 per cent oxygen inhalations if tube suction is not effective Enemas or rectal tubes are utilized for distention of the colon Heat to the abdomen in any form is of no great value except as it may add comfort The value of the high Fowler's position to assist in localization is questionable Opiates are of value for gross discomfort or restlessness They eliminate long peristaltic waves, but otherwise do not help to localize infection Chemotherapy is used in every case

Preoperative Preparation and Surgical Treatment Correct fluid and electrolyte imbalance obtain blood for transfusion, insert a Levin tube, empty the stomach and leave the tube in Remove the source of contamination, if found an inflamed appendix, perforating foreign body, rupture of a viscus or abscess, leakage from a suture line in the gut, etc

If the peritonitis is generalized, effective drainage is impossible and useless if localized, drainage is possible and useful If the exudate is not frankly purulent and the offending source is removed, drainage is not necessary or desirable Drainage is usually instituted when a frankly purulent exudate is present and occasionally to forestall an anticipated collection of blood, bile or other fluid In the latter situation the drain should be removed as soon as fluid drainage ceases, usually after two to three days If an inflammatory exudate is present, the drain should be left in until discharge ceases, or until a serous discharge remains The drain should be of a material that does not become adherent and should be withdrawn slowly (in a period of two to three days) unless it is a very short drain Drains do not drain more than the area in the immediate vicinity because they become walled off within twenty four hours

Massive parenteral chemotherapy is always given penicillin and sulfonamides or streptomycin, depending on the type of infection All these may be advisable if the infection is massive If the anaerobes predominate, penicillin and streptomycin are preferred Sensitivity tests are worthwhile for the most effective use of antibiotics Local antibiotic therapy is not necessary The sulfonamides may indeed be harmful



Fig 13 Acute diverticulitis with perforation and peritonitis Note barium escaping through the perforation

Acute Diverticulitis

Acute diverticulitis nearly always arises in the sigmoid Pain, spasm and tenderness are present in the left lower quadrant Usually a mass (the inflamed thickened sigmoid or a frank abscess) is palpable, unless spasm prevents access Nausea and vomiting are variable Fever and elevated white count are usually present There may be severe distention due to peritonitis or to obstruction Obstruction is occasionally complete, but since this is largely the result of inflammatory edema, it is transitory If the process is contiguous with

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Intestinal Obstruction (See chapter on Gastro Intestinal Disorders)



A



B

Fig 14 A Ileal loop of dog twenty four hours after venous occlusion No chemo therapy B Ileal loop of dog twenty four hours after venous occlusion Succinylsulfathiazole given preoperatively (Sarnoff and Fine Annals of Surgery Vol 121 1945)

the bladder, dysuria and pyuria are likely to be present Barium enema shows the block or the serrated outline of the involved area

Treatment is nonsurgical unless a localized abscess, spreading peritonitis or persisting obstruction is present, in which case drainage with or without transverse colostomy is done Opiates are used for symptomatic relief Local applications of heat or cold are probably without value Sulfathalidine or streptomycin by mouth are probably of value, though this is not demonstrated Parenteral sulfonamides or streptomycin and penicillin may be useful to inhibit the spread of peritoneal infection

Acute Mesenteric Thrombosis

In this condition there is more or less distention, with vague diffuse pain Nausea or vomiting may occur Constipation is the rule Melena, if present, is of considerable diagnostic value The white count is elevated well above 15,000, usually above 20,000 Tenderness is diffuse Spasm is variable There is a slow or rapid onset of peritonitis Evidence of shock due to local blood loss may appear

Treatment Since this is nearly always a fatal disease, surgery is indicated, for if the process is sharply localized, resection may be helpful Heparin or dicumarol may have value by inhibiting the spread of the thrombosis Massive parenteral and oral chemotherapy may help to abort threatening necrosis of the gut

Occlusion of the Superior Mesenteric Artery This may be due to an embolus or to a local arteriosclerotic process It is rapidly fatal The diagnosis is rarely made early Treatment is surgical and similar to that for venous thrombosis

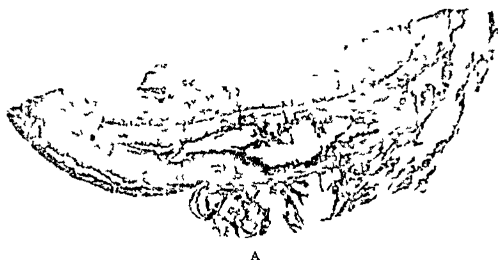
Embolism at the Aortic Bifurcation

There is always a history of chronic auricular fibrillation or recent massive coronary occlusion, usually of the posterior descending artery, with infarction of the left ventricle and a resulting mural thrombus The aortic bifurcation is partially or completely blocked Sudden violent lower abdominal midline pain radiating into the perineum or one or both lower extremities is characteristic There is a rapid onset of secondary shock One or both femoral arterial pulsations are absent or barely perceptible, with corresponding ischemic manifestations in lower extremities

If operation is possible, it must be done immediately for removal of clot If not possible, try bilateral lumbar sympathetic block and immediate heparinization (See chapter on Peripheral Vascular Dis

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ANORECTAL DISORDERS

Rectal Prolapse

This condition may occur independently or in association with the development of hernias elsewhere The etiologic mechanism is ob scure, but relaxation of the levators and the lateral suspensory ligaments of the rectum with prolapse of the cul de sac are probably the basic factors Local surgical therapy, such as excision of prolapsed tissue or plastic repair of the levators is seldom sufficient to cure the disorder The radical cure requires suspension via the peritoneal cavity Mobilization of the rectum and sigmoid with suspension to the wall of the false pelvis or to the abdominal wall and reconstruc tion of the pelvic floor so that all redundant bowel is transferred to an intraperitoneal position is required

Ischiorectal Abscess

This disorder results from a mucosal erosion in the crypts of Morgagni with a resulting burrowing infection into one or the other ischiorectal space There is edema, redness and acute tenderness over one or both spaces and the pain is severe Incision and drainage is required and is usually followed by prompt healing, but the healing is rarely complete or permanent A fistula in ano is the usual sequel

Fistula-in-ano will not heal spontaneously The original defect in the anal canal remains unhealed and allows continual reinfection of the tract of the fistula Cure requires obliteration of the internal opening which is to be found, with rare exceptions, a very short distance proximal to the external sphincter Operation is done by coring out the whole fistula, including the internal opening, dividing the external sphincter at the point where the fistula traverses the rectal wall, if necessary, in order to do this Recurrence is certain if the intestinal opening is not excised The whole bed of the fistulous tract is packed with petrolatum gauze Healing is rapid and sphincter control is preserved so long as the muscle has been severed at only one point on its circumference

Volvulus of Sigmoid

There is massive gaseous distention and complete obstipation The rapid accumulation of gas is due to rapid decomposition of the fecal mass by bacteria in a partly devitalized gut, which cannot absorb or expel the contents of the twisted loop of sigmoid The volvulus may be released by a slow steady introduction of barium from below If this is not successful, operative reduction with or without resection is indicated without delay, if strangulation is to be avoided

Torsion of omentum is a rare condition, which produces an acute disorder simulating appendicitis or peritonitis A mass may be palpable A peritoneal tap will disclose blood Immediate operative resection is desirable, though spontaneous resolution may occur A mildly painful disorder in the left lower quadrant suggesting diverticulitis can be due to a *twisted appendix epiploica* of the sigmoid A correct preoperative diagnosis is seldom made and it is usually an unexpected or incidental finding at operation

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There is massive gaseous distention and complete obstipation The rapid accumulation of gas is due to rapid decomposition of the fecal mass by bacteria in a partly devitalized gut, which cannot absorb or expel the contents of the twisted loop of sigmoid The volvulus may be released by a slow steady introduction of barium from below If this is not successful, operative reduction with or without resection is indicated without delay, if strangulation is to be avoided

Torsion of omentum is a rare condition, which produces an acute disorder simulating appendicitis or peritonitis A mass may be palpable A peritoneal tap will disclose blood Immediate operative resection is desirable, though spontaneous resolution may occur A mildly painful disorder in the left lower quadrant suggesting diverticulitis can be due to a *twisted appendix epiploica* of the sigmoid A correct preoperative diagnosis is seldom made and it is usually an unexpected or incidental finding at operation

A *twisted ovarian cyst* produces severe constant pain in the right or left lower quadrant, fever, leukocytosis, peritoneal irritation and spasm of the abdominal wall A mass is always palpable unless the patient is too obese Shock may develop quickly Immediate resection is required and if blood loss is substantial, a blood transfusion is given

CHAPTER 17

ANORECTAL DISORDERS

Rectal Prolapse

This condition may occur independently or in association with the development of hernias elsewhere The etiologic mechanism is obscure, but relaxation of the levators and the lateral suspensory ligaments of the rectum with prolapse of the cul de sac are probably the basic factors Local surgical therapy, such as excision of prolapsed tissue or plastic repair of the levators is seldom sufficient to cure the disorder The radical cure requires suspension via the peritoneal cavity Mobilization of the rectum and sigmoid with suspension to the wall of the false pelvis or to the abdominal wall and reconstruction of the pelvic floor so that all redundant bowel is transferred to an intraperitoneal position is required

Ischiorectal Abscess

This disorder results from a mucosal erosion in the crypts of Morgagni with a resulting burrowing infection into one or the other ischiorectal space There is edema, redness and acute tenderness over one or both spaces and the pain is severe Incision and drainage is required and is usually followed by prompt healing, but the healing is rarely complete or permanent A fistula in ano is the usual sequel

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Fissure in ano

This is a slit or crack through the mucosa in the anal canal, which may go on to form a large ulcer Spasm of the irritated sphincter just beneath the defect results in pain during and more especially for some minutes or hours after defecation Constipation is the rule Often one cannot enter the canal with the examining finger without severe pain and it may be necessary to inject novocain to relax the sphincter and visualize the lesion In most cases it is precisely in the center of the posterior margin of the orifice Early or mild cases can be relieved or cured by injecting a few cc of nupercaine in oil into the sphincter through the skin nearby No other treatment ordinarily is needed If this treatment, which relaxes the sphincter and relieves the pain at once, is not followed by healing, it should be repeated once or twice The fissure can be cured by dividing the sphincter, which is often visible in the base of the fissure, with or without excision of the margins of the fissure No other treatment should be required after this is done

Internal Hemorrhoids

Hemorrhoids are submucosal varices Prolapsing internal hemorrhoids are treated by surgical excision Nonprolapsing hemorrhoids, if not obliterated by 5 per cent quinine and urea injections, may also be treated by excision The indications for surgical excision are chronic discomfort, continued bleeding or ulceration with complicating infection Hemorrhoids can and should be removed without injuring the sphincter Gross postoperative discomfort and urinary retention are due to trauma to the sphincter The operation should not be done under local anesthesia The practice of extreme dilatation of the sphincter in order to obtain adequate exposure is harmful and not necessary

External Thrombosed Hemorrhoids

These are not necessarily related to internal hemorrhoids and frequently occur as an isolated disturbance As a result of strain, e g, from severe cough constipation or local trauma, a vein at the mucocutaneous margin breaks and a small clot forms and produces a bluish lump which is tender or persistently annoying Evacuation of the clot through an incision under local anesthesia will provide immediate relief The incision should not be sutured Excision of the hemorrhoid is superior to incision and evacuation The relief is prompt and no residual mass is left

Pilonidal Sinus

The patient is not likely to present himself for this disturbance until infection sets in. A discharge or pain due to abscess is generally the chief complaint. If acute infection is present, this is treated first and excision performed weeks after subsidence of the acute process.

The discouraging results of surgical treatment in the past were caused by ready fecal contamination of the surgical wound and by failure to observe established surgical principles. In nearly all instances excision and primary closure should produce a cure. The old practice of excision and healing by second intention is unsatisfactory and unnecessary. If the excision is confined to the involved tissues only (this is as a rule a limited area), if the wound is dry when sutured, the tissues approximated carefully at all levels so as to leave no dead space and so as to restore the normal depression of the anococcygeal raphe, if the skin is closed with care to get accurate eversion and approximation, if the dressing is sealed, penicillin given for four or five days postoperatively and fecal contamination avoided, the results will be entirely satisfactory in nearly every instance. Postoperative bed rest is not necessary for more than three or four days, but activity is limited for about two weeks. The sutures are not removed until the eighth or ninth day.

Preoperative Preparation for Anorectal Disorders

Enemas the day before and several hours before operation are useful, but a completely clean bowel is not necessary nor easily achieved. A light breakfast may be allowed the morning of operation unless general anesthesia is to be used.

Postoperative Care

Hot, moist compresses are comforting and cleansing. Between periods of such therapy and during the night a petrolatum gauze dressing is comforting. Hot sitz baths are also comforting, but as a rule cannot be taken until the third or fourth day. At the same time bowel evacuation is started by a retention oil enema followed in two hours by a saline enema. The postoperative diet can be a normal diet as soon as the patient can take it. Reflex urinary retention should be treated by allowing the patient to stand to void, by local heat, relief of pain. Catheterization is a last resort. After fistulectomy or hemorrhoidectomy it is wel to insert a lubricated gloved finger daily into the rectal canal to prevent adhesions.

CHAPTER 18

THE BILIARY TRACT

Acute right upper quadrant disease should suggest the following choices in diagnosis, approximately in the corresponding order of likelihood acute cholecystitis, ruptured peptic ulcer, acute hepatitis with or without abscess formation, acute hydronephrosis, acute pancreatitis, acute pleuritis, acute appendicitis, myocardial infarction, acute congestive heart failure

Differential Diagnosis

In *acute cholecystitis* the pain is continuous for hours, varying in intensity, with or without radiation to below the angle of the right scapula, to the epigastrium or to the left upper quadrant The right costal margin shows restricted mobility, there is tenderness and spasm in the right upper quadrant A mass may be palpable or not and if so, its size is in large part due to adherent omentum The lateral border of the mass is generally felt just lateral to the rectus and has the globular shape of the gallbladder in contrast to the sloping sharp edge of an enlarged or ptosed liver Low grade jaundice may or may not be present and if so, there is an accompanying hepatitis and cholangitis or common duct stone Constitutional signs of inflammation and a leukocytosis are present

Ruptured peptic ulcer produces generalized spasm There is no constitutional reaction to inflammation for the first six hours at least, during which the white count is not elevated There is air under the diaphragm and pain is not usually lateralized, although there is occasional exclusive reference to the right lower quadrant

Acute hepatitis seldom produces severe pain unless there is a liver abscess If so, the fever is high (40 5° C or more) and the leukocyte count is high also No mass is palpable except that the lower border of the liver may be lower than usual, tender on deep inspiration and may show a rounded lower edge by roentgenography

Acute pleuritis will cause pain sharply aggravated by deep inspiration and relieved on splinting the costal margins There may be

an accompanying pneumonitis Jaundice is unlikely, though possible No mass is palpable in the hypochondrium

Acute appendicitis always begins with pain and is followed by nausea Until peritonitis occurs, the temperature usually does not exceed 38 5° C Reference to the right lower quadrant occasionally occurs in cholecystitis A palpable mass then may be mistakenly considered to be an appendiceal abscess, unless care is taken to observe that the mass extends up to the costal margin

Acute hydronephrosis, unless infected, will not produce signs of inflammation The urine or the intravenous pyelogram will help to differentiate There is no reflex spasm in the right upper quadrant or jaundice and the mass, if palpable, fills the flank and costovertebral angle, both of which are tender

Myocardial Infarction Previous cardiac symptoms, the presence of pain referred to more typical areas, the fall in blood pressure and the electrocardiogram help to differentiate

Acute pancreatitis usually has a left sided pain component and a characteristic boring pain in the upper lumbar region of the midback The blood amylase is some 200 units or more in less fulminating cases and some 2000 units or more in severe cases The test becomes negative two to three days after onset There is nearly always vomiting, which is not common in cholecystitis Spasm is more generalized and shock is present or imminent

Preoperative Preparation

Surgery may be done during the acute or subsiding stage or later The advantage of early operation is that peritonitis from perforation is avoided, but since this is rare, later operation is preferred by many because exposure of the common duct, which is so often desirable, is more easily obtained after the acute inflammatory reaction has subsided

Because hepatitis may be present and basilar atelectasis with postoperative pneumonia is a not infrequent sequel, penicillin may be given prophylactically Vitamin K is not necessary unless jaundice is present or unless a vitamin K deficiency, as demonstrated by a prolonged prothrombin time, may have resulted from old liver disease or from associated intestinal disease with defective absorption, such as regional ileitis, ulcerative colitis, neoplasm or polyposis of the colon, sprue, etc A dose of 2 or 3 mg of 2 methyl 1 4 naphthaquinone orally daily for three days, together with bile or bile salts will restore a normal prothrombin time If there is a prothrombin deficiency which is in urgent need of correction, vitamin K_1 oxide

in water suspension can be given intravenously for reestablishment of a safe prothrombin level within twelve hours It is necessary to measure the prothrombin level in cases in which the need for vitamin K is clearly indicated, both before and after its administration In severe liver disease vitamin K therapy may prove ineffective and reliance must be placed upon transfused fresh blood as the sole source of prothrombin No other special preoperative procedures are required, unless the history suggests long standing hepatic damage In that case, time is needed to recondition the liver by restoring glycogen and protein reserves (see below) and by correcting any associated disorders, such as fluid and electrolyte imbalance, anemia and the like Chloroform, avertin or sodium pentothal are contraindicated for anesthesia if the liver is damaged

Chronic cholecystitis without stones is not considered a surgical disease because cholecystectomy is an unreliable method for relieving the patient of symptoms which are attributed to it

Chronic cholecystitis with cholelithiasis is a surgical disease because relief of symptoms and the avoidance of complications cannot be achieved without surgery Persistent jaundice is a serious and urgent complication it usually signifies obstruction of the biliary tract with resulting damage to the liver Jaundiced patients, therefore, should be operated on with reasonable promptness and the common duct should be explored The absence of jaundice does not relieve the surgeon of responsibility for *exploring the common duct* when operating for cholelithiasis, if other indications for so doing are present These are a thickened or distended common duct, muddy bile on aspiration of the common duct, small stones in the gallbladder, a dilated cystic duct, a previous history of jaundice, a history of vomiting during attacks of colic, indicating tension in the duct system, a palpable stone in the duct, a positive cholangiogram, cholesterol crystals in the bile obtained by duodenal intubation, or a history of typhoid fever

The extent of liver damage should be determined in advance of operation, so that appropriate preoperative measures to improve liver function may be applied While persistent jaundice is certain evidence of severe liver injury, the absence of jaundice does not preclude it In any case in which the liver is directly or indirectly involved in a disease requiring surgery, liver function tests should be performed (See chapter on the Liver)

Since cholangiograms are taken during operation with increasing frequency, an operating table fitted with a Bucky diaphragm is used in operations on the biliary tract

Postoperative Care

Acute cholecystitis is an inflammatory rather than an infectious disorder Even so called acute empyema is usually a collection of cholesterol crystals in suspension rather than a purulent exudate The wound, therefore, heals by first intention

All patients are drained after biliary tract surgery to provide a vent for blood or serum and because of the possibility of leakage of bile If there is a catheter in the duct system, it or another drain will serve to prevent peritonitis or abscess formation from exudate or bile which is easily infected by secondary contaminating organisms In order to assure good healing, however, the drain must be left in undisturbed for some eight or nine days It is then removed slowly Its premature removal or its extraction all at once may leave behind a puddle of exudate in Morison's pouch Not infrequently this is followed by sepsis and delayed recovery

A small amount of biliary drainage postoperatively is quite com mon and probably escapes from a denuded liver surface in the region of the gallbladder bed This subsides after a few days Occasionally a profuse flow of bile is evident soon or within a few days postopera tively, because of slipping of the ligature on the cystic duct or leak age around a tube in the common duct While this is annoying and requires frequent changes of dressings, it, too, will subside within a week or ten days as a rule and is no cause for alarm, so long as the drain provides an easy vent for its escape If the wound is not drained, as some have recommended, such a development can be disastrous because bile peritonitis is likely to result

Management of Common Duct Drainage

The tube for this purpose drains into a small bottle fitted with a two hole rubber stopper, attached to the binder If tension in the duct system is high and slow decompression is desired, clamp con trol of the rate of drainage is utilized This is rarely necessary If there is no hepatitis or cholangitis and the duct system is clear and unobstructed, the tube is clamped for several hours a day after the first five days and for two whole days before removal of the tube, which is done between the tenth and fourteenth days

Cholangitis severe hepatitis, or grossly dilated bile ducts after clearance of obstruction, are an indication for prolonged drainage, i e, a number of weeks, until a normal biliary tree is visualized on the x ray film If this is the regimen, it is we l to clamp the tube for a few hours several times a day in order to force some bile into the duo

denum to facilitate normal digestion After removal of the tube, bile drainage ceases within a few days

Before removal of the tube a cholangiogram is performed to assure patency Fever and local discomfort resulting from the cholangio gram may be forestalled by several doses of penicillin If there is pain as a result of clamping the tube, obstruction should be suspected Failure of entry of the contrast medium may be due to sphincter spasm, which may be relieved by atropine As a rule, however, ob struction will be due to stone The x ray interpretation of residual stone should have regard for the possibility of artefacts resembling stone in the cholangiogram because of the injection of air bubbles Residual stone in the common duct requires reoperation, unless, by chance, judicious irrigation with small amounts of ether, combined with the administration of parenteral atropine sulfate and magnesium sulfate by mouth, should succeed in washing the stone through into the duodenum Another, less painful technic is the instillation of some 15 cc of 1 500 nupercaine for thirty to forty five minutes, fol lowed by a saline irrigation These maneuvers are seldom successful

Patients who have been or are jaundiced should continue to re ceive vitamin K and ox bile or a cocktail of their own bile until the jaundice has cleared and bile is entering the duodenum

If a patient soon after cholecystectomy develops jaundice for the first time, the chances are good that the common duct is blocked as a result of surgical trauma If re exploration for repair of the injury is not performed at once, the tension in the duct rapidly rises Rupture of the duct or slipping of the cystic duct ligature may result from the tension A profuse flow of bile will appear in the wound If the wound has not been drained, biliary peritonitis and death may follow If the wound is drained, a *total biliary* fistula will result These patients eventually may develop nutritional deficiency unless vitamin K and bile are swallowed or fed by tube

Repair of the injury will be necessary sooner or later Repair by res toration of continuity, if possible, is far more desirable than implanta tion of the upper end of the duct into the jejunum End to end suture of the mucosa of the severed ends, so as to preserve the sphincter function, gives the most satisfactory results Vitallium tubes cannot be relied upon to bridge a gap because they may become obstructed by incrustations eventually

Common duct obstruction from stone or neoplasm, if of long stand ing, may result in complete absorption of bile pigment from the duct system A greatly dilated common duct containing "white bile" under tension will be found at operation This "white bile" is a

secretory product of the bile duct mucosa The liver damage may be so severe in such instances that the decompression may be followed by an absence of flow of bile for several days postoperatively, or by the excretion for many days of an extremely dilute though copious bile Since the intraductal pressure may be as high as 300 mm of water, complete liver failure may follow because the sudden release of tension may produce vascular engorgement and further inter ference with hepatic cell function This is one of the causes of the so called hepatorenal syndrome, in which renal failure is secondary to the widespread and rapidly disintegrating effects of liver failure

Liver failure following surgery also occurs for other reasons Oc casionally surgery on the biliary tree may be followed by hyperpy rexia (fever up to 41° C or higher) and rapid collapse and death This complication is especially likely as a result of inadvertent ligation of the hepatic artery, with resulting massive necrosis of a large portion of the liver

CHAPTER 19

THE LIVER

SOME NUTRITIONAL CONSIDERATIONS IN LIVER DISEASE

Maintenance or restoration of integrity of the liver is desirable whether the liver is directly involved in the surgical disorder or is impaired for other reasons Apart from the need for achieving general nutritional balance and providing a nutritional reserve, it is occasionally necessary or at least desirable to apply nutritional therapy directed specifically toward the liver A high protein, high carbohydrate, low fat diet will serve this purpose

There are, in addition, specific nutritional elements that serve to enhance the integrity of the liver Fat deposition in the liver is a manifestation of a nutritional defect Choline inhibits the deposition of fat Since choline is synthesized from methionine, which is a donor of methyl groups for this synthesis, methionine is given to patients with liver disease to prevent fat deposition This substance is especially indicated in chronic hepatitis and in the cirrhoses In acute hepatitis there is an increased excretion of methionine The resulting deficit in methionine suggests that its administration in acute hepatitis might be beneficial, but this has not been demonstrated Alcoholic cirrhosis is no longer regarded as strictly the result of alcohol poisoning but as a manifestation of the accompanying prolonged inadequate dietary intake Early cases of alcohol cirrhosis respond favorably to a high protein, high carbohydrate diet Methionine is also given, but proof of its effectiveness awaits the acquisition of more data on the amount required The toxic effect of doses in excess of 15 grams daily must be considered

The hypoproteinemia and hypoalbuminemia of advanced liver disease is probably the result of deficient synthesis of proteins, as indicated by an accompanying decrease in fibrinogen and prothrombin The lowered serum proteins are not improved by a high protein diet, but salt poor serum albumin intravenously may increase them There is some doubt as to the relationship of diminished serum albumin to ascites, which, like premenstrual edema and nephrotic edema, may be due to retention of sodium or to an antidiuretic sub

stance which the liver cannot inactivate or which cannot be excreted The lowered resistance of hypoproteinemic patients to infection may be due to inadequate synthesis of antibody globulins by the liver, but the therapeutic role of gamma globulins in these circumstances has yet to be evaluated

SURGERY OF THE LIVER

Disturbances of the liver which are primarily surgical are infrequent They include direct trauma, excisable tumors or cysts and solitary liver abscess Surgical access to the liver is also required in conditions involving neighboring structures, such as subdiaphragmatic abscess, total gastrectomy, vagotomy for peptic ulcer, etc

Most of the anterosuperior surface of the right lobe is not easily accessible, but approach to it, when necessary, as in traumatic rupture or liver abscess, is possible by section of the costal margin and diaphragm under intratracheal anesthesia

The posterior surface can be approached, usually for the purpose of draining a subdiaphragmatic abscess, by resecting the twelfth rib, taking care not to invade the pleura The inferior surface is readily accessible through an upper abdominal incision The whole left lobe can be excised It is readily mobilized for excision or for access to the cardio esophageal junction by dividing the left coronary ligament

Portal Hypertension

Cirrhosis of the liver is a nonsurgical disorder, but if it is accompanied by a portal hypertension which is causing repeated hemorrhage or a splenomegaly which is troublesome, surgery may be indicated Splenectomy is curative for the splenomegaly when the latter is caused by intravascular obstruction in the splenic vein If the obstruction involves the portal system proximal to the entrance of the left coronary vein, splenectomy is only palliative to the extent that its removal reduces the size of the vascular bed Eventually the hypertension builds up again and esophageal varices will rupture again For the treatment of portal hypertension causing exsanguinating hemorrhage, one can short circuit the portal system by anastomosing the splenic vein to the renal vein This is technically less difficult (but the results are less satisfactory) than anastomosis of the portal vein to the vena cava Splenorenal anastomosis has failed in a substantial percentage of patients (thirty per cent) probably because of subsequent thrombosis of the anastomosis, with recurrent hemorrhage If prior splenectomy has been done and has failed, the

esophageal coronary venous system may be resected by doing a partial or total gastrectomy The initial choice of procedure depends on the site of obstruction in the portal system

Ascites complicating cirrhosis of the liver is sometimes treated surgically Anastomosis of a renal pelvis to the parietal peritoneum is rarely successful A plastic cylinder inserted so as to connect the peritoneal cavity to the subcutaneous tissues of the abdominal wall, with excision of the deep fascia so as to inhibit the development of an impermeable rigid fibrous wall around the cavity receiving the fluid, also may work occasionally The operative diversion of portal flow may also relieve ascites due to portal hypertension

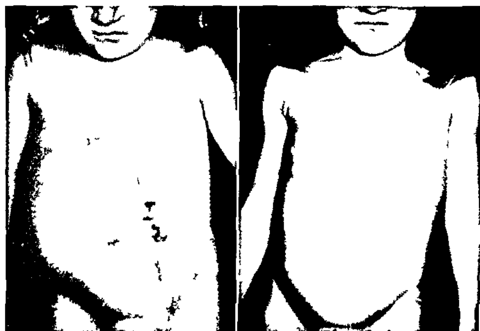


Fig 15 Infra red photographs of a five year old child The photograph on the left was made twenty six days following the establishment of a splenorenal shunt Note the absence of dilated superficial veins and of distention of the abdomen in the photograph on the right taken fifteen months following operation (A Blakemore in Bancroft and Wade Surgical Treatment J B Lippincott Co Philadelphia)

These measures do not attack the basic problem, which in some cases is due to portal hypertension and in others to increasing liver deficiency, with the retention of sodium and therefore of water by an as yet obscure mechanism In rare cases, especially of early cirrhosis, improved nutrition alleviates the condition

Trauma to Liver

Trauma to the liver, *except when caused by a missile, usually re*sults from a blow against the lower ribs or the costal margin The

resulting hemorrhage may be rapidly fatal or cause profound hemorrhagic shock Local symptoms are muscle rigidity and pain If blood reaches the central tendon of the diaphragm, as is so often the case in ruptured spleen and ectopic pregnancy, there is pain referred to the supraclavicular fossa The findings on abdominal examination will simulate peritonitis There is a leukocyte count in excess of 20,000 A peritoneal tap will disclose blood Even if shock disappears or has been treated effectively, spontaneous arrest of hemorrhage does not justify conservative management, since secondary massive bleeding is likely Hence, laparotomy should be performed Fractures of the liver may be sutured or packed with gel foam, with or without thrombin



Fig 16 High fever pain in left epigastrium Large abscess in left lobe of liver drained with recovery Note the compression of the stomach by the enlarged left lobe of liver

Liver Abscess

An amebic abscess may or may not require drainage Nonamebic abscess, unless multiple, diffuse and inaccessible, must be drained The etiology is frequently an overlooked or neglected appendicitis, but often no cause can be found The diagnosis is difficult X ray films are useful Fever is extremely high, 41° C or more, pain may be

severe, jaundice may or may not be present, the liver is enlarged, the lower border rounded and tender, the white count is high and toxicity extreme Delay is dangerous Massive chemotherapy is combined with surgical therapy

Subdiaphragmatic Abscess

This usually results from appendicitis or other cause of a septic peritonitis, such as ruptured viscus or liver abscess There is pain in or near the liver and a fixed high diaphragm is present by percussion and by radiography In many instances the process subsides spontaneously, but drainage is often required This is not done transpleurally The abscess is reached best as a rule by a posterior approach, occasionally by an anterior approach

LIVER FUNCTION TESTS

(See Chapter on Laboratory Procedures)

Physiologic Considerations The clinical usefulness and the interpretation of tests of liver function are conditioned in part by the fact that the large reserve in liver function permits adequate performance in the presence of serious damage The liver may be extensively invaded by carcinoma, yet normal function may be preserved by the capacity of the remaining islands of normal cells On the other hand, a diffuse but mild injury involving all the liver cells may be easily detected by certain function tests The evidence now available indicates clearly that the function of the liver is disturbed comparatively frequently in the course of many infectious toxic, metabolic, endocrine and circulatory disorders Marked fluctuations in liver function in the course of acute disease may be found The rate of cellular regeneration and return of liver function is influenced by the nutritional status of the patient, the character and quantity of food ingested or given parenterally, the supply of certain vitamins and accessory substances (methionine, choline, folic acid, Vitamin A and B complex), many of which are as yet unidentified, the presence of systemic disease, the rate and volume of blood flow through the liver and mechanical factors such as obstruction of the common duct with resultant back pressure and hydrohepatosis

A thorough testing of liver function would include a study of each of its multiple activities In practice this is not necessary Liver damage can be detected by testing certain functions of the liver cell, especially the excretory and detoxifying processes, which are more susceptible to injury than others For example, the same liver cell

synthesizes glycine from carbohydrate and utilizes it in detoxifying certain substances and in the synthesis of bile salts

Since most liver function tests are quantitative, but do not always run parallel in determining the degree of liver injury, it is usually advisable to perform several tests simultaneously in order to obtain a valid appraisal of the functional state of the liver There are a few qualitative tests which are comparatively insensitive in the presence of moderately advanced liver disease, but which in certain conditions yield valuable information as to the mechanism of the underlying disturbance

The choice of liver function tests is determined by the information desired, e g, the degree of disturbed function or the response to therapeutic measures in the preoperative and immediate postopera tive period or for the differential diagnosis of jaundice

Excretion Tests

These tests measure the ability of the liver to clear the blood stream of various dyes which are injected intravenously They are primarily quantitative and yield data of a general nature as to the state of the liver without disclosing the character of the pathologic disorder In the presence of jaundice they are rarely informative, since the liver has already demonstrated its inability to excrete biliru bin

In the absence of jaundice the excretory power of the liver may be measured by injecting specially purified bilirubin to see whether the liver can excrete more than the normal amount of circulating bili rubin The injected bilirubin immediately becomes indirect and is not excreted by the kidneys or retained by the reticulo endothelial system A reliable method for the quantitative determination of bilirubin is the photometric method of Malloy and Evelyn *

Of the various dyes which may be employed bromsulfalein enjoys the widest acceptance A dose of 5 mg per kg of body weight is in jected intravenously in one vein After two minutes and again after forty five minutes a blood sample is drawn with other syringes from another vein The serum obtained after clotting is made slightly alkaline with 0 1 normal sodium hydroxide to bring out the color of the dye Values above 4 per cent at forty five minutes indicate abnormal retention of the dye The test is more likely to be positive in long standing and comparatively advanced disease than in the milder but more acute disturbances known to accompany most of the conditions amenable to surgery

* Malloy and Evelyn Journal of Biological Chemistry *119* 481 1937

Urinary Bilirubin and Urobilinogen Test

Bilirubin giving the "prompt direct" reaction may appear in the urine before the serum bilirubin is elevated and before the appearance of clinical jaundice Patients sometimes notice dark colored urine for several days before they become icteric In certain cases of acute hepatitis without jaundice, the detection of bilirubin in the urine may be an early and the only manifestation of disturbed excretion of bile pigments The simplest and most reliable test is the Harrison Spot Test (See chapter on Laboratory Procedures)

Urobilinogen, which is reabsorbed from the intestine by way of the portal vein, is reconverted in large part to bilirubin by the normal liver A small amount of unconverted urobilinogen may appear normally in the urine In certain conditions the amount of urobilinogen in the urine may be increased or absent entirely In severe acute hepatitis the excretion of bilirubin by the liver may cease for a short interval For a day or two urobilinogen can be detected in the urine because of continuing absorption of what is still present in the intestine Thereafter the urine is free of this substance until the liver resumes the excretion of bilirubin The amount of urobilinogen in the urine then increases considerably above the normal value and remains at a high level until liver function improves In hemolytic types of jaundice urinary urobilinogen is increased because of the flooding of the circulation as a result of the excessive amount of bilirubin which is excreted into the intestine In complete extrahepatic obstructive jaundice, such as occurs in neoplasm of the head of the pancreas or of common duct stone, there is persistent absence of urobilinogen in the urine because of complete exclusion of bilirubin from the intestinal tract From the foregoing discussion it is evident that urobilinogen excretion tests are informative if performed serially every second or third day until the diagnosis is established Thereafter they may be done periodically to follow the restoration of liver function The tests are useful qualitatively and quantitatively

The excretion of urobilinogen is best measured by the Watson or the Wallace Diamond test on a fresh two hour specimen of urine The patient voids at 9 A M and drinks a glass of water A specimen is collected at 11 A M for the determination The normal range by the Watson test is under 1 0 Ehrlich unit or a negative test in a dilution greater than 1 to 20

Flocculation and Turbidity Tests

Three tests are included in this group cephalin cholesterol flocculation, thymol turbidity and thymol flocculation These proce

dures are based on alterations in different fractions of the serum proteins, particularly the gamma globulins and the albumen The *cephalin-cholesterol flocculation test* is the most sensitive of the three The *thymol turbidity test,* which is reported in arbitrary units with a normal range varying from 0 to 6 units, is somewhat less sensitive but has certain advantages, such as uniformity of antigen, simplicity in technic and speed (thirty minutes to complete) The sensitivity of the *thymol flocculation test* lies between these two tests

These procedures do not actually test liver function, but serve as an index of active disease Since the degree of shift from normal values for these tests is not identical, the underlying mechanisms are not identical Hence one test cannot be substituted for another The cephalin cholesterol flocculation test is so sensitive that a transitory functional impairment may be detected in the absence of organic disease A persistently positive test, especially when associated with a positive thymol turbidity test, indicates organic disease of the liver Hence the cephalin cholesterol flocculation test is most valuable in detecting early hepatic impairment The thymol turbidity test is the most helpful of the three in differentiating hepatic from obstructive jaundice Following relief of obstructive jaundice by surgical procedures and the disappearance of the icterus, the bromsulfalein test surpasses any of these as an indicator of functional rehabilitation of the liver

Carbohydrate Tolerance Tests

The oral carbohydrate tolerance tests are based on the fact that within certain ranges of concentration the absorption of any individual sugar from the intestinal tract proceeds at a constant rate, whereas the deposition of glycogen in the liver proceeds at a comparatively slow rate for approximately two hours and then is rapidly accelerated The resultant of these two physiologic activities is the early accumulation of the sugar in the circulating blood, with a consequent glycosuria if the concentration exceeds a critical level When liver function is impaired and glycogenesis is retarded for several hours, the continuing absorption of sugar from the alimentary tract is reflected in a hyperglycemia and glycosuria

The *galactose tolerance test* is the most useful one, but only in the patient with jaundice If employed *early* in the presence of jaundice, it is, as a rule, positive in hepatic parenchymatous jaundice and negative in extrahepatic obstructive jaundice Later in the course

of hepatic jaundice the test may become negative because there is early restoration of the capacity of the liver to handle carbohydrate But in persistent obstructive jaundice the progressive deterioration of the liver will produce a positive test

The oral galactose test is performed by giving the fasting patient 40 grams of the sugar dissolved in 500 cc of water and collecting the urine for five hours for quantitative determination of sugar The upper limit of normal is the excretion of 3 0 grams in five hours When the test is performed on a diabetic person, glucose is removed from the urine by fermentation before the quantitative determina tion is made

The intravenous galactose test requires 1 cc per kg of body weight of a 50 per cent galactose solution injected intravenously and a blood sample taken in seventy five minutes In normal controls no galac tose remains in the blood The intravenous galactose test may be used in jaundiced and nonjaundiced patients with liver disease

Detoxifying Tests

The conjugation of benzoic acid and glycine to form hippuric acid is the best known of all detoxification mechanisms The excretion of hippuric acid under given conditions is dependent on the amount of available glycine and proceeds at a constant rate in normal sub jects regardless of the amount of sodium benzoate administered The synthesis of glycine by the damaged liver is deficient so that the excretion of hippuric acid is decreased In the presence of impaired renal function, especially when associated with elevation of the blood nonprotein nitrogen, the test is unreliable

In the performance of the test the patient takes 6 0 grams of sodium benzoate dissolved in 30 cc water after a light breakfast The urine is collected hourly for four hours Normally at least 3 grams of hippuric acid are excreted in the urine during this period

A modification of the test employs 1 7 grams of sodium benzoate in 20 cc distilled water, which is administered slowly intravenously The urine is collected one hour after the injection Normal values range from 0 70 to 0 95 gram Decreased amounts have the same significance as in the oral test

Both tests are strongly positive during the first few days of acute hepatitis, following which there is a rapid return to normal The tests are less helpful in chronic hepatitis or for determining residual im pairment

Alkaline Phosphatase

The determination of the serum alkaline phosphatase has been proposed as a qualitative test of liver function, which may be useful in differentiating intrahepatic from obstructive jaundice Normal or slightly elevated values are found in acute virus hepatitis, whereas higher values (over 20 units) are not unusual in obstruction of the duct system Since the ducts may be blocked by cholangitis, the test has a somewhat limited value

Cholesterol and Cholesterol Esters

The factors which control the concentration of these substances in the serum are not well understood The normal range for total cholesterol is 170 to 250 mg per 100 cc , of which 75 per cent are esters In severe hepatitis the percentage of cholesterol esters decreases significantly, but the total serum cholesterol is normal or only slightly diminished In extrahepatic obstructive jaundice, the total serum cholesterol may be normal or elevated, but the percentage of cholesterol esters remains unaltered The test is helpful in the differential diagnosis of jaundice if performed early in the course of the disease, but it is not useful as a quantitative test of disturbed liver function

Prothrombin Time

Under certain conditions the determination of the prothrombin time may have diagnostic or prognostic value In the presence of severe and prolonged jaundice, whether due to hepatitis or extrahepatic biliary obstruction, the prothrombin time may be increased considerably above normal If there is a prompt return to normal following the parenteral administration of vitamin K, the jaundice is more likely to be obstructive When the prothrombin time is well above normal and fails to respond to vitamin K, the liver is severely damaged and the prognosis is unfavorable

Total Protein, Albumin and Globulin

A decline in the total serum protein occurs in liver disease only when the process is chronic and well advanced Since numerous other conditions may produce the same effect, the value of this determination is not specific for assessing liver function It is primarily useful as an index of the capacity of the liver to synthesize plasma proteins An increase in total proteins due to increased globulins is seen in

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CHAPTER 20

THE PANCREAS

Pathologic Physiology

Since the pancreas is a retroperitoneal organ, pain from it is referred via the posterior somatic segments to the midback at about the level of the first lumbar vertebra Peptic ulcers penetrating into the pancreas, acute pancreatitis and carcinoma of the pancreas will cause pain in this area or just to the right or left of it In addition, pain may be felt anteriorly as a result of involvement of contiguous structures The pancreas for surgical purposes is accessible via a rent in the gastrocolic or gastrohepatic omentum Removal of the head of the pancreas requires removal of the duodenum as well, owing to their intimate relationship and their common blood supply

Excision of the tail and body of the pancreas for pancreatic cyst or tumor produces no metabolic disorder Excision of the head only rarely produces a metabolic disorder (steatorrhea) from the absence of external secretion Nevertheless, an optimal nutritional state is best achieved following such a procedure by the ingestion of pancreatic enzymes in the form of "Pancreatin" tablets Since atrophy of the remnant will occur, except for the islets, the possible loss of another internal secretion ("lipocaic") has led to the additional practice of administering choline or methionine to prevent fat deposition in the liver

Hyperinsulinism is usually due to a hyperfunctioning islet adenoma in the pancreas or in an aberrant pancreatic rest The syndrome consists of attacks, during fasting or upon exertion, of dizziness, nausea and vomiting, pallor, sweating and even convulsions The attack may take the form of a psychic seizure, with amnesia, confusion or mania If the diagnosis is suspected, an attack should be induced to confirm it The diagnosis rests on a correlation of the symptoms with a blood sugar below 70, preferably below 60 or 50 mg per 100 cc The low blood sugar level necessary to induce an attack will be reached after an eighteen or twenty four hour fast with or without exercise These patients will show a marked hypoglycemia five to six hours after a standard glucose tolerance test,

multiple myeloma, nephrosis, Addison's disease and cirrhosis of the liver

The following table shows the changes in the five most useful *tests for the differential diagnosis of jaundice* Of these the cephalin cholesterol test might be omitted because it signifies the same changes as the thymol turbidity test and requires forty eight hours to complete, as compared to thirty minutes for the latter

	TOTAL CHOLESTEROL	PERCENTAGE OF CHOLESTEROL ESTERS	CEPHALIN CHOLESTEROL FLOCCULATION	THYMOL TURBIDITY	ALKALINE PHOSPHATASE
Obstructive Jaundice	Elevated	Normal	Negative or +	Negative	20 units or more
Hepatocellular Jaundice	Normal	Reduced	Elevated ++ or more	Elevated ++ or more	15 units or less

proliferation of the duct epithelium The diagnosis in a classical case is not difficult if violent pain in the small of the back, sudden in on set, is accompanied by epigastric and left sided pain anteriorly, nausea, vomiting and a rigid upper abdomen, together with shock or impending shock If the patient is seen early in the attack and the *blood amylase* is of the order of some 200 to 500 units, surgery is contraindicated and treatment is symptomatic This includes con stant gastric suction drainage to inhibit humoral activation of the pancreas, fluid and electrolyte therapy, paravertebral block as in dicated to relieve the pain, blood transfusions, etc

If the blood amylase is of the order of 2000 units, surgical drainage is indicated, for the mortality is otherwise substantially greater Survival from the immediate attack, whether treated surgically or not, is often followed by prolonged debility and eventual death or by the development of an abscess or cyst requiring drainage or by the loss of a sufficient amount of pancreatic substance to produce dia betes

There are patients who give a history of recurrent attacks of the milder form of acute pancreatitis, varying in intensity with each attack and lasting from a few hours to many days, with no residual evidence of the disease between attacks The diagnosis can be made by elevation of blood amylase (and lipase) during the attack and only in rare cases by the eventual development of signs of pancreatic insufficiency viz, diabetes, steatorrhea or chronic digestive dis turbances in the absence of gallbladder or gastro intestinal disease Common duct drainage has been recommended for such patients The rationale and the value of such therapy is not established

There is a growing belief that if suppression of enzymatic secretion by the acinar tissue could be achieved, a better therapy for acute pancreatitis would result Vagotomy, in addition to constant gastric suction, or subtotal gastrectomy to eliminate secretin, are being explored as alternatives to surgical drainage

Carcinoma of the head of the pancreas produces persistent and complete biliary obstruction in contrast to the obstruction from stone, which now and then permits some bile to get through If clay-colored stools persist for longer than three weeks in a case of "pain less" jaundice, carcinoma of the head of the pancreas or of the ampulla of Vater is likely Pain in carcinoma of the head of the pan creas, however, is more often present than absent The tumor as a rule does not invade the mucosa of the duodenum or common duct The block is usually the result of external compression of the duct Occult blood, therefore, is not ordinarily found in the stool, whereas

whether the peak is normal or high The syndrome may occur in a person with diabetes A glucose drink will abort the attack In a severe case, frequent glucose feedings may be a necessity to avoid alarming symptoms

Differential diagnosis requires the exclusion of Addison's disease, chromophobe adenoma of the pituitary, hyperthyroidism, severe liver damage and certain psychoses associated with an unstable autonomic nervous system

Treatment of the disorder is ultimately surgical Inhibition of insulin production by the adenoma may be attempted in mild cases by giving a low carbohydrate diet with 10 to 20 units of insulin with each meal

The tumor is usually single and is most often found in the body or tail of the pancreas It feels harder than the gland and has a capsule Most of the tumors are benign Occasionally no tumor is found, and on the assumption that the islets are hyperactive, a subtotal pancreatectomy is done Not infrequently small tumors cannot be felt and escape removal unless a total pancreatectomy is done

When subtotal pancreatectomy is performed for hyperinsulinism in the absence of a discrete islet tumor, hyperglycemia occurs and insulin is required, but eventually this is not necessary, evidently because new islets form or old ones hypertrophy

A total pancreatic fistula may occur after surgical or other trauma to the duodenum This is a grave development not only because the rapid and extreme loss of fluid and electrolytes, chiefly sodium, requires replacement, but also because the tryptic action of pancreatic juice is activated by the bile and duodenal mucosal secretion and so becomes highly destructive to the tissues of the wound and is extremely difficult to control Constant suction is utilized Raw ground meat is a useful local application to ameliorate the digestive action of the tryptic ferment In cases where the fluid is not irritating because activation by bile, intestinal juice or tissue juice is not occurring the fistulous tract, if of long standing may be cored out and anastomosed or implanted into the jejunum

Acute pancreatitis produces violent pain vomiting and shock The latter is due to hemorrhage or loss of plasma resulting from severe inflammatiory reaction The cause of acute pancreatitis though not established, is believed to be obstruction to the free flow of external secretion, at a time when the flow is abundant and the secretion pressure is high This is suggested by the fact that attacks often begin after a large meal The obstruction is only rarely due to a gall stone at the ampulla and is more likely the result of metaplastic

proliferation of the duct epithelium The diagnosis in a classical case is not difficult if violent pain in the small of the back, sudden in on set, is accompanied by epigastric and left sided pain anteriorly, nausea, vomiting and a rigid upper abdomen, together with shock or impending shock If the patient is seen early in the attack and the *blood amylase* is of the order of some 200 to 500 units, surgery is contraindicated and treatment is symptomatic This includes con stant gastric suction drainage to inhibit humoral activation of the pancreas, fluid and electrolyte therapy, paravertebral block as in dicated to relieve the pain, blood transfusions, etc

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it is likely to be found in *carcinoma of the ampulla of Vater* A palpable mass develops only late in the course of the disease The diagnosis of carcinoma of the pancreas, in the absence of jaundice, in time for surgical intervention to be useful is extremely difficult Pain radiating to the back and a rapid loss of weight are the best clues Steatorrhea, glycosuria and distortion of neighboring structures in x ray studies may be helpful, but they are inconstant findings and therefore rarely of much value Duodenal intubation for recovery of pancreatic enzymes may be performed Secretin, given intravenously, will produce a copious flow of fluid containing water and electrolytes, especially sodium, while mecholyl produces a less copious flow rich in pancreatic enzymes A poor or negative response to these stimulants indicates obstruction of the pancreatic duct or the ampulla If the carcinoma is already palpable, the prospects for more than transitory relief are dim Surgical extirpation of the head of the pancreas by the Whipple technic or any of its modifications is now an accepted procedure because of the increasing percentage of postoperative survivals Five year cures however, are rare

Preoperative preparation is the same as for other conditions in which the liver has suffered injury—a high carbohydrate and high protein diet and vitamin K These patients are intubated before the operation and the surgery is best done under spinal anesthesia

Two stage procedures should be avoided, if possible, because the long interval between operations permits unrestricted growth of the carcinoma A biliary fistula will result from any technic which leaves the common duct ligated instead of implanted in the jejunum Such a fistula is a graver complication than a pancreatic fistula The latter may be avoided by implanting the severed end of the pancreas into the jejunum although it has not been demonstrated how far such an implantation allows continued normal function of the remaining acinar tissue If implantation of the pancreatic duct is not done, it is not uncommon to find a pancreatic fistula developing postoperatively in spite of ligation of the pancreatic duct and suture of the cut surface of the residual gland If the excretion becomes activated by bile or other tissue enzymes, digestion of the skin and wound edges will occur Continuous suction and the application of ground raw meat to the wound will help to control its digestive action If the secretion is not activated as is the case when it escapes directly to the outside from the open end of the duct, it is a clear, harmless, watery fluid The latter type of fistula may close spontaneously or may eventually require implantation into the jejunum

Calculi of the pancreatic duct may produce severe epigastric pain The cause of the pain is not likely to be determined until the radiographic evidence is secured Calculi should be suspected if the pain becomes worse after eating Resection, bilateral lumbodorsal sympathectomy or splanchnicectomy or incision of the pancreas so as to expose the duct and evacuate calculi from it, may provide relief



Fig 17 Patient aged forty five had a palpable epigastric mass for twenty years For four years there was left upper quadrant distress and finally anorexia and weight loss led to operation with disclosure of an intracystic papillary carcinoma distorting duodenum stomach and transverse mesocolon

Cysts of the pancreas produce a palpable mass They may be silent otherwise, or they may cause pain in the back or the left epigastrium, nausea and anorexia and occasionally chills and fever They are difficult to distinguish from other tumors in this general location except that cysts or tumors of the pancreas are usually fixed and immobile Their removal is desirable and possible if they are not densely adherent and have a relatively small pedicle Other wise they may be marsupialized Splenectomy may facilitate the excision

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marrow Aside from the low platelet count, the blood findings are those due to secondary anemia A leukopenia or abnormal forms in the smear indicate that a blood dyscrasia exists, in which case the purpura is quite secondary A bone marrow biopsy will help in the differential diagnosis

Death from cerebral bleeding occurs more often than from exsanguination elsewhere Remissions and relapses are more common in women and they may last for years In children, in whom the disease appears as a complication of infection, the disease is self limited, gets well spontaneously and splenectomy is not indicated Transfusions are used as required in all types of purpura and in any case before and during splenectomy

Splenectomy is not always curative Hence, though the spleen is a vital factor in the depletion of platelets, some other factor may be involved This other factor is considered by some to be a toxin, which destroys platelets and possibly injures the capillaries The capillary disturbance has been attributed to excessive histamine production by the spleen *

The Splenomegalies

Hodgkin's disease, the leukemias and polycythemia vera are the commonest causes of splenomegaly Surgery for these is not only useless but even harmful Other causes of splenomegaly, such as malaria, amyloid disease, syphilis, beriberi, kala azar, schistosomiasis and leprosy, are also nonsurgical disorders

Solitary tuberculoma, abscess, echinococcus cyst and dermoid are treated by splenectomy Von Jaksch's anemia is a profound anemia of children which tends to get well spontaneously Immature red and white cells appear in the smear and there is a leukocytosis Splenectomy occasionally alleviates the condition *Hemolytic icterus* produces anemia, increased fragility of red cells and spherocytosis Hemolytic crises, causing pain and fever and increased jaundice, are more severe in the acquired type Splenectomy is curative in the congenital type Cholelithiasis is common in both types In *Gaucher's disease* splenectomy is occasionally done merely to relieve the child of the discomfort from the huge mass

Splenic anemia or Banti's syndrome is usually but not always associated with cirrhosis of the liver Leukopenia, anemia and evidence of portal hypertension are present (See discussion of portal hypertension on page 183) The spleen shows perisplenitis, fibrosis,

* Quick A M The Hemorrhagic Diseases Charles C Thomas Company Springfield Illinois 1942 p 128

CHAPTER 21

THE SPLEEN*

This organ supplies red cells on demand There is a rhythmical variation in its volume and it contracts in response to a fall in oxygen tension The macrophages in its sinuses pick up dying red cells, which become more fragile within the spleen Splenectomy is followed by an increase in resistance of the red cells to hemolysis and an increase in platelets even in normal blood, but particularly in purpura hemorrhagica, in which the platelet count often rises rapidly as soon as the splenic pedicle is ligated

The spleen cannot be felt until it is enlarged by at least a third When it is readily accessible below the costal margin, a needle puncture into it for diagnosis may be made, but not if the enlargement is acute and the gland is soft, for hemorrhage or sepsis may result

Torsion of the spleen is rare because the organ is fixed by its parietal peritoneal attachments If it occurs, infarction sets in quickly and immediate splenectomy is required *Traumatic rupture* results from a hard blow against the left costal margin Exsanguinating hemorrhage may occur very rapidly Even if a fracture of the spleen has resulted in only mild blood loss, which has apparently ceased, splenectomy is required, since delayed profuse hemorrhage is not unlikely A ruptured spleen produces local pain and spasm, pain referred to the left supraclavicular area (diaphragmatic irritation by blood) and leukocytosis due to hemoperitoneum

Primary thrombocytopenic purpura is relatively rare and is seen characteristically in adult females The secondary form, which is more common, occurs in infection, in diseases of the liver and in allergic states Surgery is seldom required in the secondary form, for it disappears if the etiologic factor is eradicated Spontaneous hemorrhage, petechiae and ecchymoses as a result of insignificant trauma, a prolonged bleeding time, normal coagulation time, a positive Rumpel Leeds tourniquet test and a deficiency in platelets are the earmarks of the disease

The spleen is only slightly if at all enlarged Megakaryocytes are found in the splenic pulp and are functionally overactive in the bone

* See section on Anemias and Blood Dyscrasias

CHAPTER 22

GYNECOLOGIC DISORDERS*

Technic of Pelvic Examination

Be gentle, use a glove on the vaginal hand and lubricate it well Inspect the vulva for kraurosis, Bartholin cyst, condylomas and neoplasm, then spread the labia with the ungloved hand, noting the presence or absence of urethrocele, vaginal or urethral discharge If discharge is present, observe the vaginal mucous membrane for inflammatory reaction and make a smear for trichomonas infection With one or two fingers of the gloved hand depress the perineal body so as to stretch and relax it and then introduce a well lubricated speculum to observe the cervix If there is a history of metrorrhagia or bloody discharge, observe for carcinoma of the cervix (Schiller test and vaginal smear) Look for polyp, Nabothian cysts, erosion or uterine discharge Examine for cystocele, rectocele or enterocele, degree of descent of the cervix on straining and tenderness of the cervix on motion Such tenderness is the result of pelvic inflammation or endometriosis, as a rule Palpate the fornices for fullness and note whether the depth of the posterior fornix is obliterated by a mass in the cul de sac (neoplasm, pelvic abscess, etc) Now grasp the uterus between the two hands and observe its size, position, irregularities and mobility If it cannot be felt because the patient is not relaxed, you may have been too rough already, the patient has been or is being hurt or she is unduly apprehensive Reassurance, gentleness and mouth breathing will help to relax the patient If the body of the uterus cannot be felt in spite of adequate relaxation, it may be retroverted and the abdominal hand should be shifted while the vaginal hand gently but firmly lifts the uterus upward and forward If the patient is too fat, use anesthesia A "frozen" pelvis is due to pelvic inflammation, endometriosis or widespread neoplastic invasion Needling of the cul de sac sometimes helps in the diagnosis Palpation then proceeds with defining the size and position of the ovaries Occasionally they can be felt, more often not, unless they are enlarged Observe mobility and consistency of masses such as tubo ovarian abscess, ectopic pregnancy, location of tenderness, etc

* See section on Endocrine Diseases

endophlebitis and thrombotic occlusion in the splenic vein or venous obstruction in the portal system proximally The patient is pale, may be faintly icteric, complains of the weight of the spleen and has vague gastro intestinal distress If the platelet count is low, the bleeding tendency from esophageal varices is marked, and splenectomy may be of considerable benefit If the platelet count is high, splenectomy may be followed by thrombosis in various vessels But splenectomy alone is not permanently curative if the venous obstruction is proximal to the splenic vein In that case it is necessary to anastomose the splenic vein to the left renal vein or the portal vein to the inferior vena cava

The vaginal smear is prepared as follows Cells are collected by a curved glass pipette from various parts of the canal, including the fornices, and spread on a cover slip over an area of 2 inches Before the smear dries, it is dropped into 95 per cent alcohol, then blotted dry, cleared in xylol, stained with Shorr's stain and mounted

FUNCTIONAL DISORDERS

Hypomenorrhea

Hypomenorrhea signifies scanty menstruation, consisting either in mere staining or a normal flow lasting two days or less Like oligo menorrhea, which means normal but infrequent periods, hypomenorrhea often is the antecedent of amenorrhea Both may coexist Three types of hypomenorrhea are recognized (1) In the *normal type* there is an anomaly of the unknown endometrial bleeding factor There is usually a well defined premenstrual secretory phase in the endometrium and fertility is unimpaired It does not eventuate in amenor rhea and no treatment is required (2) In the *endocrine type* a moderate degree of hypopituitarism is usually the cause In a few, there is primary deficiency of the ovaries with little estrogen and no progesterone production Rarely, primary hypothyroidism is the cause The diagnosis rests upon (a) premenstrual endometrial biopsy showing proliferating or atrophic endometrium, (b) low gonadotrophin excretion and (c) the presence of clinical evidence of hypothyroidism or hypopituitarism The best treatment is the ad ministration of small doses of stilbestrol (1/10 mg daily) during the first twenty days of the cycle This, plus a good diet, is sufficient to stimulate the pituitary to induce better estrogen and progesterone production by the ovary Occasionally, small doses of progesterone (5 mg daily) are needed for five days following the twenty days of estrogen therapy If hypothyroidism is present, thyroid in daily doses of 0 1 to 0 2 gram is given In most cases therapy is needed for some three to four months (3) In the *uterine type* there is an inherent endometrial defect which renders it unresponsive to normal hormonal stimulation The endometrium is hypoplastic The best treatment is stilbestrol in doses of 0 5 to 1 0 mg daily for twenty days, beginning on the second day of the flow, followed by proges terone, 10 to 20 mg daily for five days Therapy is needed by most patients for a period of about four months only

Amenorrhea

If menstruation has never occurred, the amenorrhea is *primary* If more or less normal menstruation has occurred, it is *secondary*

Vaginal Smear

The vaginal mucosa reflects gross changes in ovarian function during reproductive life, the thickness being roughly proportional to the estrogen supply During pregnancy the vaginal mucosa attains maximum thickness After the menopause a progressive thinning occurs Hormonal behavior is reflected in cytologic characteristics and staining reactions of the superficial squamous cells and the deeper layers

Marked estrogen deficiency is indicated by the presence of many cells from the basal layer, many of them mitotic, numerous leukocytes, histiocytes and mucus This type of smear is found in castrates, senile women and in severe ovarian deficiency or severe menopause If some cells from the intermediate layer are present, estrogen deficiency is moderate This is characteristic of the menopause If most of the cells are of this intermediate or transitional variety, the deficiency is slight This is seen in a mild menopause, in older women without menopausal symptoms and in young women with amenorrhea, hypomenorrhea and similar disorders

Cyclic variations are reflected in the vaginal smear as follows In the postmenstrual phase the cells are from the superficial squamous layer and stain basophilic As estrogen increases and the preovulatory phase develops, the cells gradually become acidophilic and, in the phase of maximal estrogenic concentration, almost all cells are acidophilic The anuclear cornified cells gradually increase in number in the postovulatory phase and in patients receiving estrogens As the estrogen concentration falls off, the cells become folded, lose their bright acidophilic staining, become more basophilic, undergo cytolysis and mucification A corpus luteum effect can be inferred from the shift in staining reactions and in cellular changes Leukocytes are present in all phases, except at the height of estrogenic activity, when the smear is "clear" and contains sheets of clear squamous cells with pyknotic nuclei

If frequent smears are taken during the cycle, a fair estimate of the patient's ovarian function can be made The findings are likely to be confused, however, if there is a vaginitis, which cornifies the cells In some cases of ulceration the small round basal cells are present in addition to great numbers of leukocytes as well as the infecting organism (Trichomonas, Candida, etc) Malignant cells from cervical or endometrial carcinoma are frequently to be found in a vaginal smear While the method is not infallible (neither is biopsy of the cervix), it is a valuable adjunct if malignant disease is suspected and if an experienced observer examines the stained specimen

Most patients with secondary amenorrhea do not ovulate, a few do and are therefore fertile

The diagnosis requires the following studies stereograms of skull and chest, urinary and blood FSH, urinary 17 KS, fasting blood sugar, sodium chloride and total protein, complete blood counts and vaginal smears

Treatment If the disease is of pituitary or adrenal origin, follow the therapy outlined in the chapters on these glands If malnutrition or a neuropsychiatric condition is present, a good diet or psycho therapy is indicated In all other cases the best and most economical therapy is the use of small doses of stilbestrol (0 1 mg two or three times daily for twenty days) If this alone is ineffective, progesterone in doses of 10 mg daily for five days is given following discontinu ance of the stilbestrol The small doses of stilbestrol stimulate the pituitary to put forth more normal amounts of FSH and LH and this eventually leads to the return of normal menstrual cycles As a rule this requires only three to four months of the treatment de scribed above Thyroid medication is of no value in the treatment of secondary amenorrhea except in the rare case where the amenorrhea is one of the symptoms of hypothyroidism

Uterine Bleeding

Excessive functional uterine bleeding may be due to endome trial disturbances created by a deficient amount or a total absence of progesterone, so that the normal estrogen progesterone balance is upset Progesterone favors the conversion of estradiol into estriol, enhancing its elimination and paving the way for the normal pre menstrual fall in the estrogen level It also inhibits FSH and LH production by the pituitary An excessive premenstrual fall in the estrogen level produces premature flow, while a failure of the estrogen level to rise in the immediate postmenstrual phase produces pro longed flow Such disturbances are especially common in adolescents, young unmarried women and in the premenopausal phase In the young it is not necessary to do an endometrial biopsy, for it matters little what the endometrial status is In women over thirty five, malignancy must be ruled out

Treatment of excessive functional bleeding is based on the need for restoring the normal balance between the two hormones As suming malignancy is excluded (by curettage, if necessary), hemo stasis is the first requirement This is achieved within two to five days by oral estrogen therapy, unless the bleeding is so brisk as to re quire curettage Estrone sulfate (premarin), 2½ mg t i d or more,

The cause is an organic or functional defect in the interrelations of the pituitary, ovary and uterus Other causes are primary disturbances in the thyroid, the adrenal glands, constitutional factors such as starvation, debilitating disease, neuropsychiatric disorders and lesions of the hypothalamus

Primary Amenorrhea With the exception of ovarian agenesis (see below), primary amenorrhea always is associated with the physical and mental stigmata of eunuchism or eunuchoidism tall stature, long extremities, short torso, mental and physical immaturity The uterus is small and the endometrium atrophic Estrogen assays are extremely low, whereas the gonadotrophin assays are increased because of the uninhibited activity of the adenohypophysis The only satisfactory therapy consists of substitution with stilbestrol in daily doses of 0 5 to 1 0 mg for periods of three weeks, followed by rest periods of seven to ten days This produces periodic bleeding which is psychologically satisfying Larger doses may be required if there is marked underdevelopment of the genitalia and of the secondary sex characteristics

Ovarian Agenesis (ovarian dwarfism) This is a rare syndrome with the following features short stature, primary amenorrhea, hypoplastic breasts, external genitalia and uterus, scant pubic and axillary hair, absent or rudimentary ovaries, increased urinary gonadotrophins, subnormal to absent estrogen activity with resulting diffuse osteoporosis and delayed maturation of bone, normal or slight lowering of the 17 Ketosteroids (KS), atrophic vaginal mucosa and other congenital defects, such as coarctation of the aorta

Treatment Substitution therapy with stilbestrol is most effective in producing full feminization and growth of genitalia In younger individuals skeletal growth is also stimulated

Secondary amenorrhea is most commonly associated with nutritional deficiency, neuropsychiatric disorders, hypopituitarism, chronic infections and adrenocortical deficiency, such as Addison's disease If the amenorrhea persists for six months or longer, atrophy of the secondary sex characteristics as well as of the endometrium results from the complete absence of follicle stimulating hormone (FSH) and luteinizing hormone (LH) or adrenocortical function If the amenorrhea is intermittent and lasts only three or four months, the endometrium and vaginal smears usually appear normal except for absence of evidence of ovulation and the secretory phase In some individuals the endometrium may be hyperplastic because of prolonged estrogen production at a subnormal level without corpus luteum development and subsequent change to the secretory phase

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is preferred because it is a natural nontoxic estrogen, which does not augment the already high level of estradiol and facilitates its breakdown to inactive estriol

If hemostasis is secured, the estrogen (premarin) is continued for twenty days But during the last ten of these twenty days anhy drohydroxyprogesterone ("Lutocylol" or "Pranone") is given If bleeding recurs during the twenty days, the treatment is stopped and resumed again on the fifth bleeding day The therapeutic ratio of estrogen to progesterone is 1 8 Thus, if 7 5 mg of estrogen daily is found to be enough to stop bleeding, 60 mg of progesterone is given If more or less than 7 5 mg is needed, the progesterone is correspond ingly increased or decreased After the first therapeutic trial at these levels, the dosage can be reduced by one half Three or four series of treatments will usually correct the disturbance Endometrial biopsy should then be done to determine whether normal differentiation has been acheived If so, treatment is no longer needed

Radiation therapy is not advisable or necessary for excessive bleeding If the anemia is treated and if intensive vitamin therapy, good food and perhaps thyroid extract are administered, the therapy described above will often be effective Sterility in such patients not infrequently will be corrected

Sterility and Fertility

Chorionic gonadotrophins facilitate luteinization of a maturing follicle If given in the early luteal phase, the phase is prolonged and progesterone production is increased Estrogen production is also increased by chorionic gonadotrophins, but *only if given in the late* luteal phase The gonadotrophins induce changes in the endometrium similar to those of early pregnancy

The corpus luteum produces progesterone and estrogen for ten to twelve days and begins to do so within twenty four to forty eight hours after ovulation If pregnancy does not occur, the corpus ceases to function after twelve to fourteen days

If ovulation is defective because of hormonal imbalance and if pregnancy is desired, restoration of balance is achieved according to the method described above and ovulation can then be induced as follows From the fifth to the fourteenth day of the cycle, 500 I U of equine gonadotrophins is given intramuscularly daily From the fif teenth to the twenty fourth day 500 I U of chorionic gonadotro phins ("APL," "Gonadogen, ' 'Anteron ') is given daily If ovulation can occur, it will probably happen on the first injection of the latter, so that coition is advised at this time Most pregnancies occur during

active treatment The treatment, if unsuccessful, can be repeated once or twice at three or four month intervals, but sensitization to the equine gonadotrophins may develop and the patient must be skin tested in advance

A fertilized egg becomes implanted within ten days and within twenty four to forty eight hours thereafter chorionic gonadotrophins appear in the urine This material maintains the corpus luteum, which now continues to produce estrogens and progesterone Pregnandiol (the excretion product of progesterone) remains at 5 to 15 mg daily in the urine for the first seventy to one hundred days of pregnancy, then abruptly rises and reaches a maximum in the eighth to ninth month, falling abruptly to nearly zero a few days after delivery The rise after seventy to one hundred days is due to the production of progesterone by the placenta, for the corpus luteum begins to degenerate about this time

Abortion

Spontaneous abortion usually occurs between the second and third month, either because the placenta does not produce enough gonadotrophins to sustain estrogen progesterone formation or because the corpus luteum itself becomes defective too early to sustain the pregnancy A sharp fall in pregnandiol and lowered urinary gonadotrophins will be found in many cases of spontaneous abortion Hence, in habitual abortion progesterone should be given, beginning about the seventieth day, by pellet implantation (10 mg each) in doses large enough to make the urinary gonadotrophins and pregnandiol levels sufficiently high

Primary Dysmenorrhea

The painful periods are always associated with a secretory endometrium and ovulation They do not occur if ovulation does not take place Therefore, treatment aims at suppressing ovulation by giving large doses of estrogen 1 mg diethylstilbestrol daily for the first twenty five days of the cycle When discontinued withdrawal bleeding will occur and will be painless The treatment is effective only while it is continued It should not be continued indefinitely Androgens are also effective, but are objectionable Eight five per cent of patients may be cured by presacral neurectomy The 15 per cent failures are due to technical errors or to a psychologic origin of the pain If a patient has had the estrogen therapy herewith described and still has pain on estrogen withdrawal, it is not true dysmenorrhea and is probably of psychic origin

Endometriosis

Endometriosis is a common disease, especially between thirty five and forty years of age, producing dysmenorrhea and pelvic pain The structures involved especially are the ovaries, the cul de sac and rectovaginal septum and the broad and uterosacral ligaments, in decreasing order of frequency The involved areas act like endome trial glands, undergoing cyclic bleeding with hematoma formation, so that "chocolate" or blood cysts develop Inflammatory reaction with adhesions may progress to the point of obstructing the sigmoid or forming lesions simulating neoplasms In the uterus itself such gland implants invade the muscle layers and produce "adenomyosis," which is a cause of excessive bleeding Many patients are sterile, but if pregnancy occurs, the uterus may rupture or postpartum hemor rhage may be severe

The etiology is not known It is more common in the higher social and economic strata The symptoms are dysmenorrhea, lower ab dominal pain, sacral backache, menorrhagia, dysuria, constipation, pressure in the pelvis and dyspareunia There may be fever, muscle spasm and marked tenderness in addition to palpable masses Full ness of the fornices, nodules in the posterior vaginal wall pain on motion of the uterus, especially when lifting it forward, may help to suggest the diagnosis If the pelvic findings together with the symp toms do not suggest the diagnosis, it may have to be made by ex clusion Castration cures the disease When it is done hysterectomy is also performed, but other involved structures need not be dis turbed The disease is not necessarily progressive If surgery must be done in a young patient, a small piece of healthy ovary should be left, if possible

Functioning Ovarian Neoplasms

Ovarian Follicle Cysts These are enlarged, abnormally per sistent Graafian follicles, usually multiple, which develop probably because of derangement of the normal sequence in the elaboration of FSH and LH Depending on the age of onset, they lead either to precocious pseudopuberty or to the adult type of hyperfollicul inism, in which the leading symptom is metropathia hemorrhagica, often accompanied by uterine fibroids or endometriosis

The best treatment is surgical excision of the cyst or cysts Com plete ovariectomy is unjustified except in postmenopausal women

Ovarian Corpus Luteum Cysts These are transformation products of corpora lutea resulting from excessive accumulation of fluid in the central cavity They are usually single cysts and are

probably caused by excessive secretion of LH The most important clinical manifestation is persistent amenorrhea and a soft mobile tumor The uterus is usually enlarged The clinical syndrome is that of pseudopregnancy or simulation of tubal pregnancy The breasts may enlarge and secrete colostrum The amenorrhea is the result of the persistent progestational transformation of the endometrium, which fails to break down at monthly intervals Occasionally, severe metrorrhagia occurs after a long period of amenorrhea, probably due to eventual breakdown of the corpus luteum cyst *The Aschheim-Zondek (A Z) test is usually positive*

A correct preoperative diagnosis is not made often Most cases are operated on with a diagnosis of tubal pregnancy Surgical excision of the cyst is the treatment

Granulosa Cell Tumors These are feminizing ovarian tumors composed of granulosa like cells, which are capable of secreting estrogen and which are derived from primitive undifferentiated ovarian mesenchyme They constitute some 2 per cent of all ovarian tumors About 10 per cent occur before puberty, 45 per cent during the period of sexual maturity and the remainder develop after the menopause *In the prepubertal group* there is sexual and somatic precocity, anovulatory flow even when the flow occurs in regular cycles, enlargement of the breasts and early appearance of axillary and pubic hair and acceleration of body growth, with early closure of epiphyses In sexually mature women, somatic changes are absent, but short or long periods of amenorrhea are characteristic The amenorrhea is due to the high level of estrogen in the blood Fluctuations in this level produce irregular bleeding which is anovulatory In the postmenopausal group, the presenting symptom as a rule is irregular bleeding

Diagnostic features (1) the tumor is usually large enough to be palpable and the uterus is almost always enlarged, (2) the estrogen level in the blood is high, (3) its excretion in urine is excessive, (4) there is continuous high grade cornification in the vaginal smear, and (5) the urinary gonadotrophins and 17 KS are low

Treatment Surgical exploration is indicated even when the diagnosis is not conclusively established In the older age group occasionally a carcinomatous change in the ovarian tumor and in the fundus of the uterus occurs, so that panhysterectomy should also be done Recurrence or metastasis is rare In the younger age groups removal of the ovarian tumor alone is sufficient

Theca Cell Tumors (ovarian hyperthecosis) These tumors generally are bilateral They are follicle cysts lined by theca cells

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Theca Cell Tumors (ovarian hyperthecosis) These tumors generally are bilateral They are follicle cysts lined by theca cells

They seldom occur in women less than thirty years of age and about 70 per cent occur in postmenopausal women The clinical picture in the younger group is characterized by menstrual irregularity or amenorrhea, sterility and masculinization

The diagnostic features are bilaterally enlarged cystic ovaries, masculinization, low urinary estrogens, atrophic vaginal mucosa, moderate elevation of urinary 17 KS (20 to 30 mg) and normal FSH in blood and urine

Wedge resection of the ovaries is the operation of choice in younger women This releases mechanical pressure upon the follicle cysts and restores the normal menstrual cycle and fertility The degree of regression of hirsutism is often disappointing, even if both ovaries are entirely removed In postmenopausal women the operation of choice is removal of the uterus, tubes and ovaries, because fibroids and carcinoma may develop, if not already present

Arrhenoblastomas These are solid tumors of the ovary which produce masculinization similar to that in Cushing's syndrome They are rare and occur mostly in women of child bearing age Four types have been described, according to the degree of histologic differentiation (a) testicular, with well differentiated cells and minimal hormonal effects, (b) the intermediate form with mild hormonal effects, (c) the sarcomatous type, which is least differentiated and which has marked hormonal effects, and (d) adrenal like tumors the rarest of all, made up of large, light colored, lipoid containing epithelioid cells The latter are considered to be aberrant adrenal cortical tumors because they produce the marked hormonal effects and the same metabolic changes as in Cushing's syndrome

The clinical picture shows considerable masculinization, amenorrhea, atrophy of breasts, clitoral hypertrophy and deepening of the voice associated with a pelvic tumor The diagnosis is substantiated by the following hormonal pattern (1) normal FSH and low estrogen in blood and urine, (2) atrophic vaginal mucosa by vaginal smear and (3) low to high normal 17 KS excretion Ovariectomy is followed by a decline in 17 KS increase in estrogens and regression of virilism, with prompt return of menstruation, etc

Dysgerminomas (ovarian seminomas) These tumors are large, solid and invested with a thin capsule They are bilateral in a third of the cases Histologically they resemble the undifferentiated gonad in an early stage of embryologic development They resemble seminoma of the testis and are usually found in association with hermaphroditism or pseudohermaphroditism The majority are seen in women under the age of twenty years

Excessive secretion of gonadotrophins or a *positive A-Z test* plus bilateral ovarian tumors is diagnostic Removal of uterus, tubes and both ovaries is mandatory

Struma Ovarii (thyroid tumor of ovary) This is an ovarian teratoid which contains exclusively or predominantly normal thyroid tissue or various forms of abnormal thyroid tissue including hyperfunctioning and malignant goiter The thyroid hormone content of the tissue is usually high It is found in about 3 per cent of ovarian teratomas The greatest incidence is in women aged thirty to sixty years

The common findings are a palpable ovarian tumor and ascites The diagnosis is impossible except in cases showing thyrotoxicosis Even in this small group, however, there is usually a cervical goiter also The diagnosis is usually not made until thyroidectomy fails to relieve the thyrotoxicosis Cure follows subsequent removal of the ovarian tumor

Ovarian Chorionepitheliomas These are highly malignant epithelial tumors characterized by morphologic and functional resemblance to placental tissue There is excessive production and urinary excretion of gonadotropic hormones with changes simulating pregnancy When these tumors occur in children they produce signs of precocious puberty In adult women, irregular and prolonged uterine hemorrhages occur

Radical excision followed by deep x ray therapy is done, but it is usually futile

Benign Ovarian Tumors

Owing to the need for estrogen excretion by the ovaries in order to preserve normal calcium metabolism, it is not desirable to remove all of both ovaries for benign lesions such as cysts When apparently simple cysts are removed, they should be opened to make certain that they are free of proliferating tissue If the latter is present, radical extirpation of ovaries, tubes and uterus should be done, since neoplasms are bilateral in over 30 per cent of cases Benign cysts should, even if small, be excised so as to prevent their growth to a size requiring subsequent removal Any solid ovarian tumor, however small, requires total bilateral ovariectomy, since so many are malignant and already have involved the other ovary Exceptions are (1) ovarian fibroma, which is accompanied by ascites and pleural effusion, both of which disappear after the fibroma is removed, and (2) unilateral dermoid cyst The latter can often be diagnosed preoperatively by a scout film showing calcification of the cyst wall

Malignant Tumors of the Ovary

These are usually papillary adenocarcinomas, often arising in a cystadenoma They are frequently bilateral Half the cases are incurable when first seen The vagaries of growth in ovarian carcinoma are such that even if some of the malignant tissue is not removed, survival may last for many years Exploratory operations, therefore, should always be done on such patients and extirpation attempted As much of the neoplastic tissue as possible should be scooped out and the whole omentum should be removed Postoperative radiation is of doubtful value, since untreated cases with residual carcinoma have as good a statistical survival rate as radiated cases About one fourth to two fifths survive for five years or longer

Adenocarcinoma of the Uterus

Adenocarcinoma of the uterus commonly occurs after the menopause, usually in the sixth decade, more often in nullipara and especially in those who have had menopausal menorrhagia or who have not ceased menstruating until well beyond fifty years of age (excessive estrogenic stimulation) If postmenopausal bleeding is found not to be due to carcinoma of the cervix, excessive estrogen therapy, vaginal erosions or polyps, this lesion should be suspected Curettage should be done and if more bleeding is caused than seems warranted the likelihood of adenocarcinoma is considerable Pain or uterine enlargement are not reliable signs Vaginal smears may help in the diagnosis If a positive diagnosis is made by curettage, treatment requires preliminary intra uterine radiation with radium, which reduces tumor dissemination that might result from the curettage If the diagnosis has been made by vaginal smear, the radium is not required The dose of radium is 3500 to 4000 mg hours in a period of eight days Radical surgery is done after the radiation effects have subsided i e after six to eight weeks, unless the tumor is markedly anaplastic in which case surgery is delayed for four months in order to allow time for the growth and detection of local metastases Both ovaries and tubes and the whole uterus are excised Five year survivals average better than 50 per cent

Carcinoma of the Cervix

While the prevailing choice of therapy is still radiation, the poor five year end results have revived radical surgical procedures Radiation therapy fails often because many cervical cancers are radioresistant and because it does not influence growth which has spread to the parametrium or the nodes deep in the pelvis The surgical

therapy aims at radical excision of the lymph node chains along the common, external and internal iliac vessels, including those in the obturator foramen, as well as removal of ovaries, tubes, uterus and upper part of the vagina The operation cannot be done if cancer tissue must be cut across in the process of excising the base of the broad ligament If the patient has been treated by radiation, but subsequent evidence of spread to lymph nodes without local recurrence appears, radical extirpation of the lymph nodes including those in the groin may be attempted by an extraperitoneal approach

Carcinoma of the Vulva

Leukoplakia of the vulva is a *precancerous lesion* and *requires* vulvectomy If carcinoma is present, radical vulvectomy with bilateral dissection of the superficial and deep nodes in the groin and pelvis is essential Radiation therapy is ineffective

Chronic Cervicitis

Treatment is not necessary unless discharge or some other annoying symptom requires it Cauterization or coning out of the inflamed mucous membrane by a bipolar high frequency current is the method of choice and is effective Only in unusually advanced cases is a Sturmdorf excision required

Miscarriage and Septic Abortion

If the cervix is closed and the bleeding is slight, the case is considered a *threatened miscarriage* The patient is kept in bed, sedated and perhaps given hormonal therapy She should be allowed to continue the pregnancy but the condition often progresses to the state of *incomplete miscarriage* This diagnosis is made if the cervix is dilated and fetal tissue is seen or felt within the os If all of the products of conception have been evacuated, the *miscarriage is complete* In that case the patient is left undisturbed, providing bleeding is slight or has ceased

If not all the products of conception have been evacuated, the *miscarriage is inevitable* and may be allowed to become complete spontaneously, providing the bleeding is not severe or persistent If the bleeding is either severe or persistent, a curettage is done to evacuate the uterus Curettage is hazardous after the twelfth week and in such or more advanced pregnancies it may be safer to await spontaneous delivery or it may be necessary to perform a hysterotomy If curettage is done, avoid sharp curets, use a dull fetal blade instead If one waits, as one should in septic cases, pituitrin, quinine

or ergotrate may be used to keep the uterus firm and well contracted A miscarriage is not complete unless the uterus has shrunk and is well contracted

If bleeding is profuse and intervention is not wise, either because of sepsis or advanced pregnancy (twelve to sixteen weeks), it may be necessary to pack the uterus and vagina, give transfusions and em ploy prophylactic or therapeutic chemotherapy If the cervix is already dilated it may be evacuated by the finger, a dull curet or pla cental foreceps The infection is usually saprophytic and confined to the uterus If bleeding is active in a septic case and the cervix is not dilated, a strip of gauze packed into the canal and left in for twenty four hours may be followed by dilatation and spontaneous evacuation of the pregnancy

Ectopic Pregnancy

This may be manifest as persistent pain in the right or left lower quadrant combined with a palpable mass and one or more missed periods in a woman of the child bearing age The mass and the pain may be absent, however, and the first sign may be either vaginal bleeding or spotting or a sudden massive intraperitoneal hemorrhage With the development of shock, the patient will have a rapid pulse pallor, a falling blood pressure and may complain of pain in the left supraclavicular fossa, show a leukocytosis and a spastic abdomen Immediate laparotomy is necessary, accompanied or preceded by multiple transfusions

In cases of doubtful diagnosis, differentiation from endometriosis or pelvic inflammation may be facilitated by needling the cul de sac via the vagina under sterile precautions and, if there is time, by the A Z test

Fibroid Uterus

Fibroids arising in the lower uterine segment are more difficult to remove after they begin rapid growth because they become intra ligamentous and encroach upon the structures that must be avoided in performing hysterectomy In a young patient who wishes to go through a pregnancy, such a fibroid is an especially likely cause of dystocia in labor Fundal fibroids, on the other hand are not a seri ous contraindication to pregnancy Myomectomy for conservation of the uterus in young women may be tried, but pregnancy seldom follows Fibroids should be removed if they are submucous, pedun culated or intramural and the cause of menorrhagia or metrorrhagia Fibroids may become painful as a result of edema and degeneration

If they are small, soft and solitary, radium therapy may successfully eradicate them X ray therapy is not advisable because it may induce the menopause or activate a quiescent inflammatory process It achieves no more than radium therapy As a rule, hysterectomy is necessary for excessive bleeding The cervix should also be removed, but in young women it is desirable in so doing to be especially care ful not to distort the vaginal anatomy, which results from excessive removal of posterior vaginal wall Symptomless small fibroids require no treatment

Pelvic Inflammatory Disease

The diagnosis of gonorrhea from a smear is not nearly as reliable as by culture Acute gonorrhea confined to structures below the cervix can be cured by one or two intramuscular injections of penicillin of 300,000 units each

Chronic gonorrhea in the same area is cured the same way If residual infection persists in Skene's ducts, the latter are cauterized under novocain by electric cautery If Bartholin's glands are involved, the process is usually bilateral and excision is required

Acute pelvic inflammation does not produce a swollen pyosalpinx in a first attack If pyosalpinx is found, it is the result of repeated infection, because occlusion of the fimbriated ends must have been present prior to the infection The organism does not survive more than two weeks after the temperature is normal Other organisms in the exudate are secondary invaders The acute attack almost always begins after menstruation, during which the organisms make their ascent Surgery is not necessary for acute pelvic infection by the gonococcus Chemotherapy is effective within a few days When tubo ovarian abscess disabling pain, ovarian dysfunction or men strual disorders result, surgery is necessary To achieve a cure bi lateral tubo oophorectomy and hysterectomy are required

Hysterectomy

Vaginal preparation is necessary if total hysterectomy is to be performed Total hysterectomy is preferable to supracervical hysterectomy because carcinoma and other cervical diseases are thereby prevented When an extensively damaged cervix requires amputation, it is preferable to perform a panhysterectomy because stricture and pyometria are common sequels to amputation of the cervix *Vaginal hysterectomy* may be indicated in this situation as well as for treatment of procidentia, enterocele and other non malignant lesions of the uterus It should not be attempted if there

is any fixation of the uterus or adnexae or if the uterus is larger than a large orange For the cure of a large enterocele, it is necessary to remove the uterus in order to make the supporting structures needed for repair (uterosacral ligaments) accessible For the cure of mild or moderate procidentia, vaginal plastic procedures are adequate, as a rule, but now and then the uterus should be excised also

Preoperative preparation for vaginal hysterectomy includes lactic acid douches (1 dram to a pint of water) If there is likely to be some difficulty in mobilization of structures, the ureters may be catheterized in advance Postoperative hernia results from inadequate suturing of the uterosacral ligaments Shortening of the vagina is due to excessive removal of posterior vaginal wall

Prolapse of the uterus occasionally occurs in women who have not borne children, but in most instances results from child bearing injuries The relaxation of the cardinal ligaments allows the uterus to descend in the axis of the vagina More often than not the anterior vaginal wall also descends, forming a cystocele The relaxed perineum, which results from a dehiscence of the levator ani muscles in front of the rectum, no longer serves to resist the downward thrust of the uterus in response to an increase in intra abdominal pressure Extreme prolapse, i e , *procidentia*, may result In this situation, the "bearing down" sensation, backache and urinary frequency are accompanied by the discomfort of the exposed and irritated protruding mass

Pessaries are unsatisfactory and should be used only where the surgical risk is excessive Surgical repair formerly included *intra abdominal suspension of the uterine fundus This is much less effective* than reconstruction of the support from below, which involves repair of the relaxed perineum, apposition of the cardinal ligaments and repair of the cystocele An associated rectocele or enterocele is also repaired at the same time Vaginal hysterectomy, with support of the roof of the vagina by the uterosacral ligaments, is often desirable in advanced cases to provide a more secure and permanent result

Urethral caruncle is a vascular polypoid like protrusion of the external meatus which bleeds easily and produces burning pain on micturition It is common at the time of the menopause Treatment is excision or cauterization with a fulgurating current Recurrence is common if the lesion is not fully eradicated

Stress Incontinence of the Urinary Bladder

The etiology of this disorder is not well understood It occurs in nullipara, including virgins, as well as in women who have borne chil

dren A characteristic feature is the loss of urine as a result of strain in the standing or sitting position, but *not* during recumbency In severe cases, once micturition starts, the patient cannot stop the

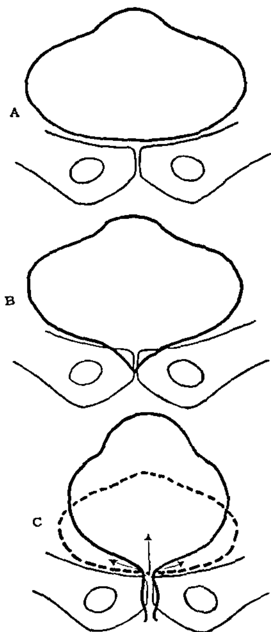


Fig 18 A Position and shape of normal female bladder at rest B Position of normal female bladder on voluntary initiation of micturition Note descent of bladder base and internal sphincter C Solid line shows position and shape of normal female bladder during micturition Arrows point to the direction to which the base is lifted in order to shut off the stream voluntarily Broken line shows shape at rest (By courtesy of Dr S Richard Muellner)

stream and the bladder empties completely, because, while the detrusor functions normally, the patient cannot close the internal sphincter Control does not require the distal two thirds of the ure

thra, since this portion can be resected without disturbing control Surgical correction of a relaxed anterior vaginal wall or a cystocele, or reefing procedures upon the urethra are not reliable to produce a cure of the disorder Radiologic study* shows that when voluntary

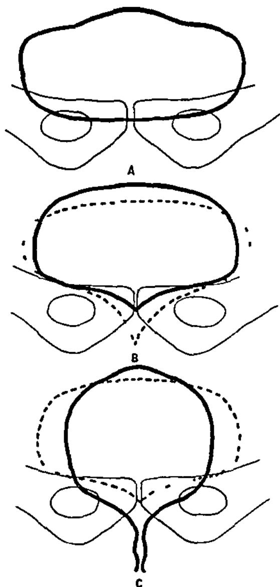


Fig 19 Compare with Figure 18

A Multipara with stress incontinence while recumbent Note position and shape of bladder base

B Multipara with stress incontinence in erect position Solid line shows pointed bladder base Internal sphincter is lowermost portion of bladder Dotted line shows effect of cough

C Multipara with stress incontinence Solid line shows bladder during micturition Note descent of internal sphincter Dotted line shows shape and position of bladder during voluntary inhibition of urinary stream In severe stress incontinence the base cannot be raised to the position of the broken line in order to shut off the stream (By courtesy of Dr S Richard Muellner)

* Muellner S Richard Etiology of Stress Incontinence Surg Gynec and Obst In Press

micturition begins in the normal woman, the bladder base descends and the urethral orifice assumes the shape of a funnel Voluntary inhibition results in a lifting up of the bladder base This shuts off the internal sphincter The pubo coccygeus, which is the anterior portion of the levator ani muscle, performs the function of lowering and raising the bladder base in order to start and stop the stream In the incontinent female, the pubo coccygeus fails to surround and support the internal sphincter, which herniates downward and remains the most dependent portion of the bladder in the erect position The sphincter alone cannot resist the effect of coughing, sneezing or gravity The newer and apparently more successful procedures for correcting surgical incontinence provide a splint to elevate and support the sphincter The splint may be a metal bar inserted and fixed behind the internal sphincter or a fascial sling looped around it and anchored to the fascia of the abdominal wall above the symphysis pubis

GENERAL REMARKS

All patients requiring operation for disease of the genital organs should be catheterized before operation A vaginal douche should be ordered the night before and the morning of operation Sterile preparation of the vagina is essential for pelvic operations requiring panhysterectomy A good vaginal preparation is a gentle scrubbing of the perineum and vulva with *p*H isoderm, followed by a shave and then by the installation into the posterior fornix by a glass tube ("soda straw") of a few cc of *p*H isoderm containing 3 per cent G 11 (dihydroxy hexachloro diphenyl methane) This is followed in one hour by a warm tap water douche

Preparation of the field for vaginal or perineal procedures should include preparing the abdominal wall as well, because it is occasionally necessary to proceed unexpectedly with a laparotomy The preoperative enema should be given the night before in order to assure complete evacuation Postoperatively, douches should not be prescribed except in unusual circumstances For discomfort after plastic procedures on the perineum, warm sitz baths or warm moist gauze compresses may be used Postoperative catheterization for constant drainage should not be done except when the surgical procedure has produced sufficient trauma to the urethra or bladder so as to require rest of the area as after plastic procedures on the urethra, inadvertent opening of the bladder, repair of vesicovaginal fistula, etc The catheter is left in for a week Occasionally, suprapubic drainage is preferable, as after repair of a vesicovaginal fistula

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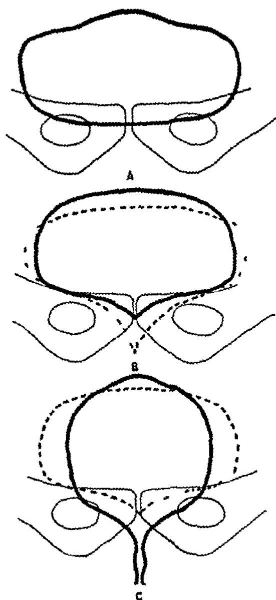


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CHAPTER 23

UROLOGIC DISORDERS*

Preoperative Considerations

Diseases of middle and advanced age constitute a dominant feature in the preoperative preparation of a large proportion of patients with urologic disorders The special hazards of sepsis and embolism have been substantially circumvented in the last decade by the introduction of antibiotics, early mobilization and more effective control of thrombophlebitis In most urologic surgery the preoperative study involves a determination of renal function by the usual blood chemical studies for renal function, cystoscopy, ureteral catheterization with split urine examinations where indicated, and radiographic methods of diagnosis

The use of rubber tubes for the divergence of urine constitutes one of the special features of preoperative and postoperative care Such tubes can become kinked or blocked or be stiff and irritating and even painful The rubber tubing must be flexible and yet not so soft as to kink Their lumina and glass connecting tubes must be free of constrictions and large enough to allow free drainage The readiness with which a drained kidney, bladder or ureter becomes infected makes it necessary to attempt to maintain complete sterility of the entire drainage apparatus This is particularly difficult to achieve because inspissated pus, blood clots and encrustations require clearing by irrigation often by a nurse or orderly, and frequently under conditions which are far from ideal

RENAL SURGERY

Bilateral disease is common in stone, infection, tuberculosis and congenital abnormalities Partial damage to the kidney which is not subject to surgery may make its burden postoperatively of carrying the whole renal load too great *A particularly apt example is con*

Special topics such as determination of renal function anuria stress incontinence stone due to hyperparathyroidism postoperative urinary retention carcinoma of the prostate undescended testicle hypertension in relation to the kidney and chemotherapy of urinary infections are discussed in other parts of this volume

genital obstruction of the ureteropelvic junction, in which failure to detect a similar though less marked abnormality on the other side may reveal itself postoperatively by the development of a severe hydronephrosis because of the added load Therefore, the individual status of both kidneys must be known before either one is operated upon, because a planned conservative type of operation may not turn out to be feasible and nephrectomy may offer a better chance for restoration of the patient's health

Pyelography, except in a pressing emergency, is an indispensable preoperative procedure Ordinarily surgery is not done until forty eight hours after pyelography because of the danger of renal sup pression The excretory pyelogram often provides a measure of renal function not revealed from the study of the split urines obtained by ureteral catheterization, concentration test, blood nonprotein nitro gen and similar tests If an excretory pyelogram is not satisfactory, a retrograde pyelogram should be done to clarify or supplement it

Preparation for excretory pyelography requires that the colon be empty and the urine as concentrated as possible, consistent with the avoidance of dehydration Fluids are generally withheld for twelve to eighteen hours, if the patient has been properly hydrated before hand If water deprivation is not practicable, ½ cc of pitressin subcutaneously twenty minutes before injection of the diodrast will, by its antidiuretic action, provide better visualization This is es pecially valuable in emergency pyelography for the detection of pelvic or ureteral stone, kinking or congenital abnormalities If excretion of the opaque medium is delayed, as by a blocked ureter, films taken three hours afterward or even later may reveal the site of obstruction

Oblique views often aid in localizing a stone in the kidney or ureter or in showing the relationship of a mass to the kidney For the latter purpose a barium meal or enema may also provide useful sup plementary information

Renal lithiasis requires routine repeated serum calcium and phosphorus levels to detect hyperparathyroidism If the latter is present, the serum calcium should be 11 mg per 100 cc or higher and the serum phosphorus should be below 3 5 mg per 100 cc If these levels are equivocal and analysis of the extracted stone reveals a content of almost pure calcium phosphate (' apatite'), a diagnosis of hyperparathyroidism is almost certain In that case recurrence of stone may be expected unless the parathyroid tumor is found and removed An excessive urinary excretion of calcium may be revealed by the Sulkowitch reagent (See section on Hyperparathyroidism)

More than four fifths of all renal calculi can be detected by radiologic study The preponderance of renal stone in males has been related to the sex linked difference in the urinary excretion of citrate The citrate ion, which is said to be excreted in much larger amounts by females during the menstruating age than by males, forms a soluble calcium citrate salt, but the administration of citrate by mouth has proved disappointing The solution of phosphatic stones in the renal pelvis and bladder by repeated irrigation with Solution "M" *(see page 225) is said to be some value when their removal* by surgical methods has not proved successful

Renal tuberculosis is always secondary to tuberculosis elsewhere, but usually appears when the primary focus is healed or quiescent However, it may be present in association with acute miliary tuberculosis Necessary surgery should not be done while the process is acute elsewhere A preoperative sanitarium cure may be required Streptomycin, 0 5 gm daily, is indicated for cure or for limitation of the process in the kidney to be removed or in the kidney to be left or in the secondary metastatic infections in the bladder, vesicles, prostate or epididymis The bladder pain and dysuria of tuberculous cystitis is considerably relieved by one 60 mg methylene blue tablet orally twice a day, combined with bladder instillations of one or two ounces of warm sterile mineral oil Once the renal lesion is removed the secondary involvement of the rest of the urinary tract improves, providing the general measures for the treatment of tuberculosis are continued postoperatively

Nephrectomy for unilateral *atrophic pyelonephritis* accompanied by hypertension may be followed by relief of the hypertension

If the cysts of *congenital cystic kidneys* are punctured the uremia may be relieved and prolonged improvement may follow

An infected *pelvic kidney* should be removed if the other kidney is present and in a healthy state

Nephrectomy for tumor should always be preceded by x ray films of the chest and bones for metastases *Tumors* of the kidney occur *in about the following proportions adenocarcinoma, 30 per cent,* hypernephroma (Grawitz tumors), 30 per cent tumors of the pelvis, 15 per cent, Wilms tumor, 7 per cent The best results of nephrectomy occur in the hypernephromas, the poorest (in adults) occur in tumors of the renal pelvis

Bilateral cortical necrosis of the kidneys due to thrombosis of cortical vessels is a rare complication of premature placental separation It occurs in males also Anuria and death follow No treatment

is known Possibly heparin or peritoneal dialysis may prove useful (See chapter on Renal Disorders in Section IV)

Acute glomerulonephritis may produce a temporary oliguria Obstructive *anuria* due to bilateral renal or ureteral calculi, tuberculous stricture, carcinomatous occlusion of the ureters, sulfonamide crystalluria or accidental surgical ligation of the ureters requires appropriate intervention to re establish urinary flow, after identification of the cause This may be evident from the history or be disclosed by the usual diagnostic measures, especially pyelography If anuria is due to reflex renal suppression, e g , after release of a long standing prostatic obstruction, diuresis may be induced by 100 cc of 50 per cent dextrose intravenously or by an intravenous drip of isotonic sodium sulfate The intensity of the uremic state in these conditions is determined by the clinical signs of increasing stupor, anorexia, hyperpnea, vomiting, ileus and the blood findings of increased nonprotein nitrogen and urea, decreased carbon dioxide combining power, anemia and rising blood pressure A low blood chloride level, if present, does not require special therapy

Acute pyelitis and acute pyelonephritis are different degrees of the same type of infectious process, which is due to retrograde or blood borne bacterial invasion of the kidney There is sometimes an accompanying cystitis and pain in the costovertebral angle, in addition to the constitutional signs and symptoms of acute sepsis Urologic study by cystoscopy is not warranted during the acute phase unless there is a previous renal disorder such as stone, obstruction to renal flow, etc An intravenous pyelogram, however, may be done in acute pyelitis If the infection is not considered to be secondary to other renal pathology and does not yield promptly to antibiotics, but persists for longer than eight to ten days, special urologic technics are needed to determine the presence of an underlying cause in the urinary tract

Antibiotic therapy is discussed under "Chemotherapy" elsewhere in this volume Sulfamethazine and Duomycin (Aureomycin) are the most effective antibiotics for gram negative organisms When antibiotics fail to clear an infection associated with an alkaline urine, mandelic acid may be useful But the need to acidify the urine and restrict fluids contraindicates its use during the acute phase of infection

Renal Injuries

Hematuria frequently occurs in renal trauma, but its appearance is sometimes delayed by urinary suppression, ureteral obstruction by

clots or tissue or as a result of complete severance of the ureter Formation of a palpable mass is often delayed Unless the large renal vessels are involved or the hemorrhage is profuse and continuous or there is evidence of urinary leakage, conservative treatment is generally indicated

Perinephritic Abscess

Perinephritic abscess is more common in men, more frequent on the right side, and the *Staphylococcus aureus* is the usual causative agent There are no pathognomonic signs or symptoms, and the diagnosis may be difficult to make A scout film may give as much information as an intravenous pyelogram Obliteration of the psoas shadow, distortion of the renal outline, fixation of the kidney and curvature of the lumbar spine are valuable diagnostic signs The abscess is generally treated by incision and drainage and chemotherapy

Postoperative Care in Renal Surgery

Postoperative hemorrhage after renal surgery may be so massive as to require immediate re exposure of the operative site and even a nephrectomy Clamps left on the pedicle at operation are removed with reasonable safety after six or seven days, but it is well to have the patient ready for immediate reopening of the wound if hemorrhage should follow

Persistent fever due to residual infection in the upper urinary tract postoperatively may require cystoscopy or pyelography to locate the septic focus

Drains should be left in for at least seven days after a pyelotomy or nephrostomy If urine continues to leak after the drain is removed this leak should stop within four days If leakage persists for more than two weeks, obstruction to flow is likely and may require visualization of the fistula or ureteral catheterization for diagnosis and treatment (by dilatation, if indicated) If the obstruction is neglected or not corrected in time, it may be impossible to achieve spontaneous closure and the need to establish permanent ureteral drainage may arise

Perinephric extravasation of urine is due to inadequate drainage from the kidney bed It may result from premature removal of the drain, from failure to use a drain or from improper placement of the drain It requires immediate correction by insertion of a drain or by releasing too tight a closure around a drain This is especially apt to occur in the posterior end of the incision

After nephrostomy, the wound should be drained for from ten to fifteen days, depending on the degree of infection, the integrity of the ureter, etc Nephrostomy tubes should be irrigated once or twice daily They should be left in for from two to six weeks If they are used as an aid in the recovery of hydronephrotic kidneys from which the obstructive factor has been removed, the length of time they should be left in is subject to dispute If a plastic procedure on the renal pelvis has been done, the longer interval is used

Permanent nephrostomy tubes, usually straight catheters, require periodic replacement under sterile precautions

If accidental injury and suture of the ureter occurs during operation and a leak follows, a nephrectomy may be necessary

Postoperative Care of Patients with Urinary Calculi If nephrostomy tubes are left in after the removal of stones and if the stones are composed of calcium phosphate or carbonate, Solution "M," containing magnesium oxide, 3 84 grams, citric acid, 32 35 grams, and anhydrous sodium carbonate, 8 84 grams per liter of water, is used for irrigation to assist in dissolving the calculi which may have been left behind If the stones are composed of urates or cysteine, a weak solution of sodium bicarbonate is used

Ten to fifteen per cent of patients have recurrence following surgical removal of stones This is likely if there is persistent infection or obstruction to free drainage

Pyelography will indicate stasis or distortion of the kidney pelvis following pyelotomy Bladder neck obstructions causing residual and stone formation are treated by resection of the neck and extraction of calculi The bladder must be re examined postoperatively to make sure that residual has been abolished

If infection is present after stones are removed, the likelihood of recurrence of stone is considerable A large fluid intake is necessary and appropriate chemotherapy is essential If it is ineffective and if the urine is alkaline, the urine should be kept acid by methenamine or mandelic acid It should be remembered that acidification by drugs which lower the blood *p*H extracts more calcium and phosphorus from bones Ammonium chloride will not acidify the urine in *Bacillus proteus* infections On the contrary, it may make matters worse because ammonia is converted to urea, which stimulates bacterial growth

Vitamin A (10 minims of haliver oil daily) is said to preserve the normal lining of the urinary tract Diets are prescribed according to the urine *p*H and the type of stone found One may use low calcium, high acid ash diets for calcium phosphate or calcium carbon

ate stones, and high alkaline ash diets for cysteine stones, or low purine diets for urate stones Calcium oxalate stones require a low oxalate intake and a highly acid urine, i e , a *p*H of about 4 5

URETERAL SURGERY

If the ureter containing a stone is dilated, the stone may shift rapidly from one level to another Therefore, when ureterotomy for stone is planned, an x ray film to show the exact position of the stone should be taken immediately before operation Occasionally a No 10 or No 11 F catheter is inserted before operation to identify the ureter and the position of the stone

Ureterotomy wounds heal by primary intention in 50 per cent of the cases and the drain is usually removed within seven to nine days If urine escapes for more than two weeks, ureteral catheterization is performed, the ureter dilated and the catheter left in place for two to three days However, a permanent ureteral fistula may result in spite of this treatment

If permanent ureterostomy is necessary, as is the case when a part is lost by surgical injury or has been resected for neoplasm, it is pref erable to transplant the ureter into the bowel Such transplantation also can be done with good results when the bladder must be excised for neoplasm, ectopia vesicae, extensive ulcerative cystitis or similar disorders

BLADDER SURGERY

Acute bladder disturbances producing severe dysuria can some times be alleviated by alkalinizing the urine with 0 6 gram of potas sium citrate, q i d , antispasmodics, local heat therapy and warm normal saline irrigations or the instillation of 30 to 60 cc of warm mineral oil Constant catheter drainage may be needed

If the dysuria is due to *bleeding,* distention of the bladder by retained clots allows further bleeding A two hole No 20 or No 22 F catheter attached to a good glass and metal syringe (Janet) for two way irrigation with warm normal saline may be tried for the evacua tion of clots A rigid bougie catheter with a Toomey syringe is more effective for large clots The Ellik evacuator attached to a No 24 cystoscope is an effective instrument, but anesthesia is necessary If bleeding cannot be stopped, cystotomy is necessary If the clots are removed and bleeding is successfully controlled, free flow is estab lished and maintained by a catheter and frequent small saline irriga tions are given A large fluid intake is also administered These

measures may prevent further clot formation should bleeding begin again

Bladder stones and diverticula are very seldom primary The underlying cause must be determined prior to surgery Papillomas of the bladder may have become implanted after descent from the renal pelvis and their presence there must be ascertained by pyelography

Cystography The bladder is filled with 2 5 per cent sodium iodide solution until the patient experiences a desire to void X ray



Fig 20 Diverticulum of bladder (with Rayopake) (Courtesy of Dr M Leopold Brodny)

exposure is made at this volume Half of the medium is then drawn off and a second exposure is made of the half filled bladder (Fig 20)

The bladder is commonly opened in the extraperitoneal space suprapubically as a preliminary procedure for prostatectomy, for the removal of large stones the excision of diverticula and tumors Once the bladder has been opened, most urologists prefer to close it to a cystotomy tube Primary tight closure may result in leakage through the suture line and in extravasation of urine A cystotomy tube puts the bladder at rest and permits quick healing If there is *no obstruc*

tion in the lower urinary tract, the fistula will heal quickly after removal of the tube If the prevesical space has been opened, a drain is inserted and is removed on the first or third postoperative day

The cystotomy tube is a No 34 F open end Pezzar or mushroom type and should be attached to a sterile glass tube and sterile distal rubber tubing of at least equal diameter The latter is connected to a sterile closed bottle as illustrated in Fig 21 The cystotomy tube and distal tubing are pinned to the binder or dressing in such a way that the patient can turn freely in bed without pulling on his tube or kinking it Irrigations of the bladder with normal warm saline solution

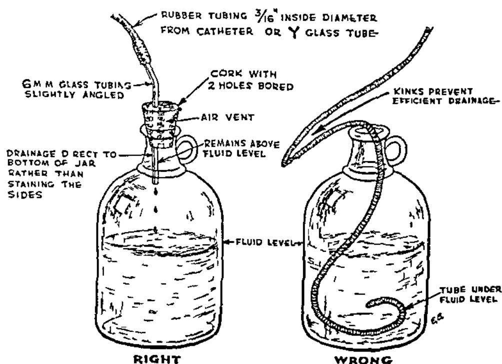


Fig 21 Proper arrangement of drainage tube into drainage jar contrasted with inefficient and messy arrangement of same (Mason and Zintel Preoperative and Postoperative Treatment)

should be held at a minimum in order to avoid bladder spasms The saline solution can be replaced by Solution "M" if alkaline and encrustating cystitis is present When bladder spasms do occur, they can sometimes be relieved by the instillation of about 30 cc of sterile warm mineral oil into the bladder, after which the tube is clamped off for ten to fifteen minutes Demerol, 50 to 100 mg every four hours or a rectal suppository containing opium 0 060 and belladonna 0 015 mg every three to four hours may also be helpful After the cystotomy tube is removed, five to ten days postoperatively, the healing of the bladder fistula can be speeded up and the

need of frequent changes of dressings avoided if the bladder is drained by an indwelling urethral catheter for a few days (Fig 22)

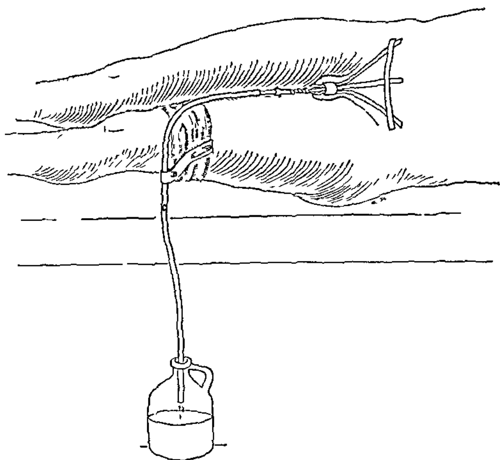


Fig 22 A strip of 3 inch wide gauze bandage encircles the lower thigh loosely (A) The band of adhesive (B) forming a loop around the drainage tube can be pinned to the gauze bandage in such a way that the weight of the distal tubing (C) does not pull on the penile attachment This arrangement allows the patient to move in bed easily (After Mr John Ruhan) (Mason and Zintel Preoperative and Postoperative Treatment)

PROSTATIC SURGERY

The optimum preoperative status for prostatic surgery should be an ambulatory patient—one with adequate cardiac reserve, with at least a fair appetite, a normal temperature, a nonprotein nitrogen below 40 mg per 100 cc and less than 20 per cent phenolsulfon phthalein retention after two hours He should be taking fluids well and should show a good urinary output, a urine free of sediment or rapidly becoming free of sediment If this state of affairs can be achieved, the surgical procedure entails a minimum of risk If not, the risk is increased, especially if emergency surgery is required

Transurethral resection is especially indicated for small fibrous prostates and median bar obstructions A natural desire to avoid a

tion in the lower urinary tract, the fistula will heal quickly after removal of the tube If the prevesical space has been opened, a drain is inserted and is removed on the first or third postoperative day

The cystotomy tube is a No 34 F open end Pezzar or mushroom type and should be attached to a sterile glass tube and sterile distal rubber tubing of at least equal diameter The latter is connected to a sterile closed bottle as illustrated in Fig 21 The cystotomy tube and distal tubing are pinned to the binder or dressing in such a way that the patient can turn freely in bed without pulling on his tube or kink ing it Irrigations of the bladder with normal warm saline solution

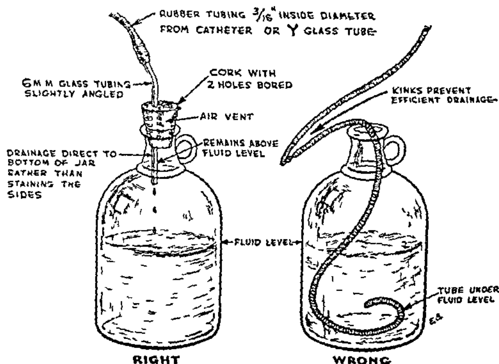


Fig 21 Proper arrangement of drainage tube into drainage jar contrasted with inefficient and messy arrangement of ame (Mason and Zintel Preoperative and Post operative Treatment)

should be held at a minimum in order to avoid bladder spasms The saline solution can be replaced by Solution "M" if alkaline and encrustating cystitis is present When bladder spasms do occur, they can sometimes be relieved by the instillation of about 30 cc of sterile warm mineral oil into the bladder, after which the tube is clamped off for ten to fifteen minutes Demerol, 50 to 100 mg every four hours, or a rectal suppository containing opium 0 060 and belladonna 0 015 mg every three to four hours, may also be help ful After the cystotomy tube is removed, five to ten days postoper atively, the healing of the bladder fistula can be speeded up and the

blocked completely Chronic urinary retention is treated by cystotomy and subsequent forcing of fluids and antibiotics or by gradual decompression through a urethral catheter The types of catheters that should be provided for this purpose include Nos 16, 18 or 20 F two hole types, or a soft coude tipped catheter, filiforms with No 14 to No 18 F followers and a stylet The stylet should have the curve of a metal sound The catheter is introduced with or without a stylet If there is great distress and straining, a narcotic will be required a half hour or more in advance Metal types of catheters are more traumatic than two holed soft rubber catheters with a stylet Filiforms and followers are more likely to be needed in strictures of the urethra leading to a greatly distended bladder

If there has been acute urinary retention, all of the urine may be drained off, especially if constant drainage will not be required and the catheter is to be withdrawn If there has been chronic urinary retention, 8 to 10 ounces is withdrawn and the large tense bladder becomes soft (If the retention is due to blood clots, cystotomy rather than decompression should be done) Thereafter, a Murphy drip tube is attached to the catheter and, by means of a pinch clamp, the flow is regulated to about 60 to 80 drops per minute The decompression will thus be accomplished within about forty eight hours If there is infection, it may be wise to shorten this period Asepsis of the entire drainage apparatus is imperative and fluids and antibiotics should be pushed The patient is left on constant drainage A two hole No 18 to 20 soft rubber catheter, held as shown in Fig 22, is used But if there is difficulty in keeping it in place, as in an obese patient with a short penis, the Foley catheter is an excellent substitute The diameter of the glass connecting tube should be as large or larger than the catheter This applies also to the tubing to the collecting bottle, which should be of latex tubing, fresh, kink free and of $^3/_{16}$ inch inside diameter The whole system should be sterile when applied If the catheter is comfortable and draining well it may remain for three to ten days The urethra may be irrigated with normal saline solution or 1 5000 potassium permanganate solution when the catheter is being changed because it is plugged by debris

When it is necessary periodically to irrigate the bladder during constant drainage, the system as described and illustrated in Fig 27 is excellent It is well to remember that because solutions introduced anywhere in the urinary tract may enter the venous system, the irrigating solution should be isotonic saline solution and must not contain boric acid or other substances which are toxic should they enter veins

two stage operation and to abolish the first stage suprapubic cys totomy has led to the development of various one stage suprapubic operations, such as Millin's retropubic procedure * These operations may possess advantages in selected cases, primarily in patients with out retention They cannot be used with complete safety in chronic retention, where preliminary suprapubic drainage of the bladder may be a life saving procedure

During the preoperative period, in addition to cystoscopic study of the prostate, a diverticulum, stone or tumor of the bladder should be looked for These additional disorders occur in some 10 per cent of patients with prostatic hypertrophy If there is hematuria, the kid neys should be investigated The technics required for these purposes may include a urethrogram, cystogram, cystometrogram, cystoscopy or pyelography Urethrography should not be done if the urethra is bleeding, after instrumentation or in the presence of acute in fection The opaque medium to be used is lipiodol mixed with sterile mineral oil in a 3 1 proportion †

In patients without retention, preliminary catheter drainage of the bladder is unnecessary if the bladder residual is less than 5 ounces Cystotomy may be done as soon as the general condition permits

The management of *urinary retention*, if present, depends on whether it is acute or chronic and whether or not one is able to pass a catheter It is not always easy to determine the first question, al though the clinical history may give some significant clues

Acute urinary retention is preceded by a fairly normal pattern of micturition, i e , there has been little, if any, increase in urinary fre quency, urinary control has been good and the amount of urine with each voiding has been more or less normal The retention occurs sud denly, is quite complete and is accompanied by a progressively in tense urge to void If catheterization cannot be effected because of urethral trauma or for other reasons, or if there is serious bladder or prostatic hemorrhage, an immediate cystotomy is required

In chronic urinary retention, before the final shut down, the patient has usually had very frequent micturition, voiding small amounts of urine Urgency, with paradoxical incontinence, is common The bladder, having become overdistended imperceptibly over a long period of time, is not apt to be as sensitive or painful when it is finally

* Millin T Lancet 2 693 1945

† Rayopake an iodized polymeric polyvinal alcohol (containing 50 per cent dieth anolamine salt of 2 4 dioxo 3 iodo 6 methyl tetrahydropyridine N acetic acid) is more miscible with water and more opaque than other available materials for radiographic visualization of the urinary tract Earlier preparations of Rayopake possessed an exces sive viscosity which has since been corrected

Proper placement of the catheter tip is shown by adequate and free return of fluid injected through it When this is accomplished, the suprapubic wound is dressed and, if the urine remains clear for a day, may be strapped with adhesive tape After three days this wound is nearly dry and after a week it is quite dry The urethral catheter not only serves the purpose of keeping the suprapubic wound dry, but prevents possible occlusion of the bladder neck by fibrotic prolifera tion Enemas are avoided for the first few days because they may excite hemorrhage The catheter is left in for ten or more days As soon as irrigation does not show fluid escaping from the suprapubic wound (seven to ten days) the latter is considered closed, but the catheter is not removed until four days later (twelfth to fourteenth day) to make sure that solid healing has occurred and that the wound will withstand the intravesical pressure upon resumption of sphincter control

Sepsis may become localized in or outside the bladder, in the prostatic bed, in the upper urinary tract, within the epididymis or testis or as osteitis of the pubic bone Localized infections subside with adequate drainage and chemotherapy Infections of the epididy mis or testis, however, may go on to abscess formation and may re quire orchiectomy for cure Osteitis of the pubic bone is characterized by marked pain or tenderness over the symphysis pubis It is ac companied by adductor spasm and locomotion may become impos sible or difficult It usually subsides after a few weeks

Transurethral resection of the prostate requires that the pro state bed be dry on completing the operation A No 22 to 24 Foley hemostatic catheter is placed Tension on this catheter is only neces sary if bleeding occurs The catheter serves for constant drainage Much bleeding may require frequent irrigations Severe bleeding requires fulguration of bleeding points via a resectoscope or supra pubic cystotomy to evacuate clots and to introduce a gauze pack or a bag If there is no bleeding the Foley catheter is removed in two to five days If pain over the bladder occurs, bleeding or distention is present If fever persists for more than four days, look for bladder residual or infection So long as the catheter is in place, chemo therapy helps but does not succeed in curing an infection, if present

Perineal Prostatectomy Following this procedure the drain age tube must be carefully watched Small gentle irrigations are given to insure adequate drainage Enemas may excite hemorrhage and should be avoided for the first four days If a urethral catheter is inserted, either at the time of operation or later, it is left in for some ten days, provided urethritis does not develop Its removal is fol

The dangers of bladder drainage in chronic overdistention are sepsis, bleeding from the bladder wall and renal suppression Bleeding from the bladder wall is not absolutely avoidable, even with the most painstaking decompression When it occurs, it is necessary to irrigate the bladder and evacuate whatever clots form Normal warm salt solution is the safest irrigating medium for this purpose

Infection can be minimized by scrupulous asepsis during catheterization and irrigation and by the judicious prophylactic use of antibiotics

Postoperative Care in Prostatic Surgery

The care of the patient after prostatectomy will vary in detail according to the choice of operation The patency of drainage tubes must be assured Bladder irrigations are not done unless necessary Excessive bleeding may occur in the immediate postoperative period or may be delayed for seven to ten days Its control will depend on the type of operation which was done and the form of bladder drainage For mild bleeding irrigations from time to time, which do not distend the bladder are desirable to prevent clot formation If the bleeding is rather brisk but not massive irrigations may be done as often as every half hour This may be sufficient to stop the bleeding, but if it is not some form of hemostasis must be used at once such as fulguration of the bleeding point through a cystoscope or the application of pressure by means of a distensible rubber bag (Pilcher, Hagner, Brake or Brodney) or a Foley catheter, or by packing with gauze or 'Oxycel' The blood loss, of course must be replaced Prolonged *hypotension* from shock in elderly patients predisposes to acute coronary occlusion

When a *suprapubic prostatectomy* has been done and a distensible rubber bag has been used for hemostasis with satisfactory results the bag can be removed in twenty four hours if release of the fluid in the bag and of the clamp holding the urethral tube on the wire frame against the pubis is not followed by bleeding A urethral catheter is inserted after removal of the wire frame and surgical dressings (When the Brake or Brodney bag is used the catheter is already in place) This must be done with strict surgical aseptic technic The distensible bag is drawn out through the suprapubic wound, drawing the antiseptically cleansed urethral tube with it The lubricated catheter, attached to the latter follows it into the bladder and part way through the suprapubic wound The catheter, detached from the tube is drawn backward into the bladder which is gently irrigated (with the patient on his side) via the catheter to wash out clots

Torsion of the spermatic cord is frequently incorrectly diag nosed as acute epididymitis Gangrene of the testicle requiring orchiectomy is the usual result of this error

Neuralgia or causalgia of the genitocrural nerve is sometimes confused with inflammation of the vas Cure will result if part of the nerve in its retroperitoneal position on the psoas muscle is excised

Varicocele Unless it is of exaggerated degree, it should not be disturbed Occasionally, the sudden appearance of a varicocele is an index of a malignant lesion in the kidney or retroperitoneal space If it is not due to such a lesion, and is so annoying that simple ele vation by a suspensory does not relieve discomfort, surgical cor-rection may be attempted This is not done by excision, but by sus pension of the cord to the fascia of the oblique muscles in the groin

Epididymitis is often secondary to infection of the prostate or other parts of the urinary tract, or it may be metastatic from distant septic foci

Orchitis If the testicle is traumatized and the tunica albuginea is ruptured, the latter can be sewn up and the testicle preserved, providing it has not been pulverized In the orchitis of mumps, an incision under pentothal into the tunica vaginalis will relieve pres sure due to viscid fluid and save the testicle

Malignant testicle is usually manifest as a painless swelling with little distortion of its natural outline It is confused with hydrocele, hematocele, orchitis, and the like Delayed therapy is usually the result of the patient's neglect Seminomas may be excised, but a prospect of cure cannot be entertained unless the inguinal, iliac and peri aortic nodes are excised and massive radiation given

Hydrocele The simplicity of the surgical cure of hydrocele is such as to make repeated tapping a poor alternative Cure can be achieved by a scrotal incision under local anesthesia and incision of the tunica vaginalis sufficient to permit extrusion of the testicle through the slit, holding it extruded by a few tacking sutures The fluid in the sac, which is formed by the tunica albuginea of the testicle, now drains into the scrotal soft tissues, from which it is absorbed without local accumulation Postoperative hematoma, so common after the bottle operation, is avoided

URETHRAL SURGERY

Female urethritis sometimes begins from the time of marriage and may be confused with cystitis The urethral orifice is hyperemic and edematous Treatment is by antibiotics and periodic dilatation

lowed by the passage of sounds to insure a channel between the membranous and prostatic urethra The perineal drainage tube is removed in four days if the urine is clear Urine leaks through the perineal wound until the internal sphincter begins to function

If control of hemorrhage necessitates the use of a Davis bag, the latter is removed in twenty four hours If gauze packing is used, it is removed in stages by the end of the third day

Epididymitis or abscess of the testicle is usually prevented by vasectomy prior to prostatectomy If epididymitis occurs, it should subside in a week or so, but if the scrotal swelling and tenderness persists for more than ten days, an abscess of the testicle may be present and orchiectomy will be required Persistent fever may be due to pyelonephritis, to retained sepsis in the bladder or a diverticulum, to pericystitis, urethritis or periurethral abscess, or to thrombophlebitis of the leg or periprostatic veins

Acute prostatitis is recognized by general signs and symptoms of infection together with painful and difficult micturition, pyuria, and the finding of a tender, tense, swollen prostate on rectal examination Chemotherapy is usually effective Conservative therapy utilizes hot, two way rectal irrigations (using two catheters, one for inflow, the other for outflow) with 1 gallon of hot (40° C) water four times a day to aid in localizing the infection It is best to avoid the use of a catheter If it must be used, use a No 12 or a No 14 F , i e , a small one If an abscess develops, it may rupture via the urethra or it may be opened by incision via a resectoscope in the urethra

Prostatic Diverticula These occur most frequently in association with chronic prostatitis and urethral stricture of long duration The prostatic ducts are not wide enough to allow free drainage The diverticula are visualized by urethrography and their walls may be fulgurated by the high frequency current Unusually large diverticula are seen in tuberculous prostatitis

Carcinoma of the Prostate (See discussion in section on Endocrine Diseases) The considerable recurrence rate, even after castration, makes it imperative to do a total perineal prostatectomy as a first choice in therapy, if the disease is found in its early stages This requires that the prostate be examined routinely in men past forty Transperineal biopsy under pentothal by the Silverman needle or Turkel's prostatic biopsy punch, using a finger in the rectum as a guide, will help to make a correct early diagnosis in posterior lesions, which are by far the most common In a lesser percentage of cases, the carcinoma occurs anteriorly and can best be observed and biopsied transurethrally

ureters or kidneys Radiography of the entire urinary tract is therefore advisable preoperatively Urethrograms are of considerable value in delineating the caliber and the number of strictures (Figs 23, 24, 25 and 26) Most urethral strictures can be readily dilated with filiforms and followers of the bougie type Spinal anesthesia is often of great aid in the passage of bougies and sounds, but because

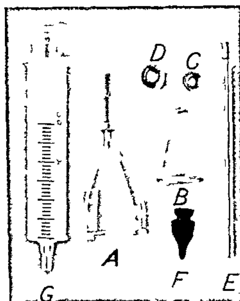


Fig 23 Kit for urethrogram (Courtesy of Dr M Leopold Brodny)

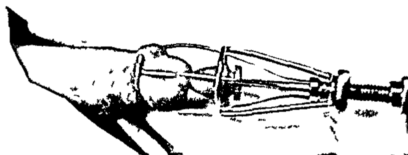


Fig 24 Kit for urethrogram assembled and in place (Courtesy of Dr M Leopold Brodny)

of the insensitivity of the urethra, these must be passed with utmost caution to avoid tearing of the urethra and the making of false passages Postoperatively fluids and antibiotics are the main requisites If external urethrotomy is required, the tubes are removed after six to nine days and the patient voids via the urethra and the perineum After two weeks, a sound is passed and this is repeated every ten days and later at increasing intervals

Polyps of the female urethra, if troublesome, may require fulguration

Traumatic rupture is revealed by bleeding, perineal hematoma or a distended bladder If the tear is at the intrapelvic level, dislocation of the prostate can be detected by a finger in the rectum If a catheter cannot be passed, immediate external urethrotomy or cystotomy is required to prevent urinary extravasation The bladder is opened suprapubically and a retrograde metal catheter is passed from above and another *per urethram* The metallic click on contact of both catheters allows the urethral catheter to be guided into the bladder It is followed by an attached rubber catheter, preferably a Foley catheter, to which traction is applied for twelve days But the catheter remains for four to six weeks longer

Extraperitoneal *rupture of the bladder* will be revealed by urinary extravasation If the peritoneum is torn at the same time, urine will enter the peritoneal cavity and the signs of peritonitis will rapidly ensue Closure of the rent and cystotomy must be done immediately

Paraphimosis

Paraphimosis is a strangulation of the glans penis by a retracted tight prepuce The edema and discoloration of the glans demand early treatment if gangrene is to be avoided A dorsal slit of the constricting band under novocain may be necessary if manual reduction to be tried first, fails

Perineal Phlegmon

This is an infection of the superficial perineal pouch which extends to the scrotum penis and anterior portion of the abdomen It is caused by a mixture of aerobic and anaerobic bacteria, probably invading via the urethral mucosa The infection can spread along the lymphatics draining these structures Colles fascia forms no barrier to the infection The sloughing and matted mucous membrane of the urethra is often mistaken for impassable stricture After deviation of the urinary stream the mucous membrane of the urethra regenerates quite promptly Preoperative studies should include urine and blood cultures and determination of the blood nonprotein nitrogen level Treatment requires prompt incision and drainage, plus the use of chemotherapy and cystotomy or perineal urethrotomy to deviate the urine

Urethral strictures are often complicated by urinary tract infection, especially chronic prostatitis and by stones in the bladder,

plegic In all of these conditions the bladder disturbance is due to paralysis of the voluntary mechanism for the control of micturition Once this mechanism has been abolished, micturition may become automatic The bladder contracts spontaneously when it is filled to the point of "critical stretch " The patient then experiences urgency,

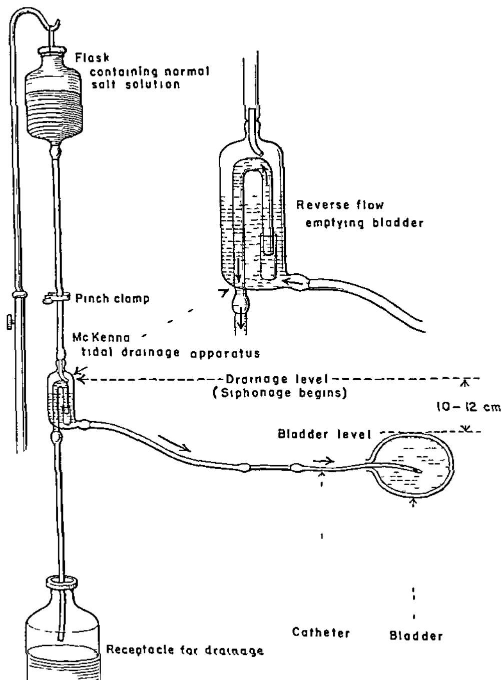


Fig 27 Tidal drainage of the bladder McKenna s apparatus is assembled as shown The height above the level of the bladder is varied depending on the volume at which emptying of the bladder is desired (Average height is 10 to 12 cm) This is determined by preliminary cystometry to determine the point of critical stretch



Fig 25 Normal urethrogram and cystogram (with ' Rayopake) (Courtesy of Dr M Leopold Brodny)

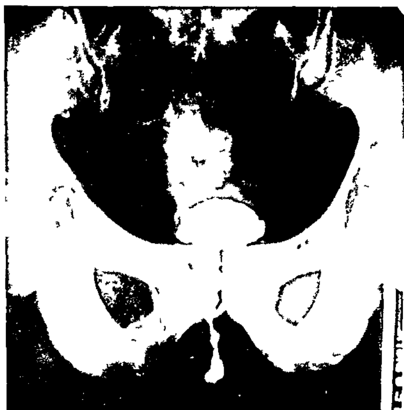


Fig 26 Prostatic abscess cavity shown by urethrography (with Rayopake) (Courtesy of Dr M Leopold Brodny)

Neurogenic Vesical Disturbances

(See section on Stress Incontinence of Urinary Bladder)

Study of the bladder in paraplegics has established the principles of management of a bladder whose nerve supply has been impaired It has been shown that the cord bladder of tabes, multiple sclerosis and diabetic polyneuritis differs very little from that of the para

CHAPTER 24

FRACTURES AND DISLOCATIONS

Plaster

Plaster of paris may be used for

1 Splints
2 Casts to immobilize the types of fractures which can be locked or held in plaster
3 Casts to immobilize sensitive joints
4 Casts to correct deformities

When using plaster one must bear in mind the following

1 The part to be covered must be cleansed
2 Stockinette is to be used whenever possible
3 Sheet wadding is to be applied over this, but not so thickly as to allow the cast to wobble at any point
4 Pressure must be avoided by the careful use of felt padding over bony prominences The common sites needing protection are the following
   a Heel
   b Internal and external malleolus
   c Upper end of fibula
   d Patella
   e Anterior superior spine
   f Sacrum

5 Casts should be applied lightly This is best done by wetting the plaster thoroughly and rubbing each layer into the previous one and holding the cast carefully until it is dry Avoid pressure dents made by fingers while the cast is drying

6 Keep fingers and toes freely exposed so that they may be observed for circulatory changes and so that they may move freely

7 Following the application of a cast, the extremity should be elevated to minimize swelling If the swelling is excessive, the cast must be split without endangering the position of the fracture

8 Pain at any bony prominence, which persists must be investigated to be sure a pressure sore is not developing

a sense of fullness in the lower abdomen, followed by sudden spontaneous uninhibitable micturition The frequency with which the bladder will empty depends on the rate with which filling beyond the permanent residual accumulates to the point of critical stretch

The goal of management in patients deprived of the voluntary mechanism, therefore, is to restore as nearly normal a bladder capacity as possible, with a minimum of infection and residual If the bladder is large and has little tone, tidal drainage, using normal saline as the medium of irrigation, is of value in minimizing infection and allowing the bladder to regain some of its tonicity McKenna's tidal drainage apparatus, and the use of a urethral catheter no larger than a No 16 or No 18 French, simplifies the problem considerably (Fig 27) Bladder capacity and tone must be checked by frequent cystometric readings When automaticity of micturition at or near normal bladder volume has been established, tidal drainage is discontinued If prolonged tidal drainage does not succeed in reducing a large bladder residual, resection of the bladder neck, as advocated by Emmett,* may be considered

The urinary tract should be checked by x ray study at intervals to detect the development of stones within the kidney or bladder For the proper rehabilitation of the patient with a cord bladder, good nursing, physiotherapy and occupational therapy are necessary

* Emmett J L J of Urol 53 545 1945

films Never be content with one view of a bone in an x ray film to rule out a fracture (Fig 28)

Watch casts postoperatively for swelling and bleeding If much edema is anticipated, bivalve the cast several hours after it is applied A cold, white or blue extremity requires immediate splitting of the cast or its removal Elevate the extremity by pillows, sandbag or suspension to an overhead frame Excessive pain means too tight a cast, infection or poor reduction Later, as swelling subsides, a new cast is required Prolonged recumbency predisposes to renal calculus,



Fig 28 The anteroposterior view shows only a minor bone injury

owing to decalcification of bones in the inactive patient Therefore, early mobilization when possible is desirable

Patients with fractures of the lower extremity show a high incidence of death from embolism Prophylactic bilateral femoral vein ligation is indicated in adults of middle or old age

Physiotherapy—heat, whirlpool baths, active and passive motion and massage—is a specialty of considerable importance in fracture cases It is well to remember that active motion is always preferable to passive motion because it more rapidly restores function and involves less danger of damage to the fracture and associated muscle system

Traction

Skin traction exerts only a limited amount of pull It cannot be used if the skin is poorly nourished or afflicted with lesions The skin must be cleansed, shaved and then painted with compound tincture of benzoin Bony prominences are protected by a layer of sheet wadding or felt The adhesive or moleskin must be held to the extremity by a smooth ace bandage which must be removed and reapplied at intervals to avoid wrinkling, which injures the skin

Skeletal traction, preferably by the use of the Kirschner wire, is the ideal type of traction One can obtain a stronger pull than with adhesive There is little danger of infection when properly used If *not checked constantly, however, to see that the pull used is not* excessive, it may produce distraction of the fracture

The wire is inserted in various safe places os calcis, lower end of tibia and fibula, upper end of tibia, lower end of femur and olecranon

Traction is used on the leg for

1 Fractures which cannot be held satisfactorily in plaster, such as the oblique or overriding types

2 Lesions of the knee or hip joint, if there is a flexion or other deformity

3 For the relief of spasm or pain in lesions of the hip joint or knee joint

4 For the relief of sciatic pain

5 For severely displaced pelvic fractures

Traction is used on the arm for overriding fractures and contractures of the elbow or shoulder

GENERAL CONSIDERATIONS IN THE TREATMENT OF FRACTURES

All fractures must be seen and treated at once Opiates are indicated unless there is a head injury Type and cross match the blood If shock is present, it should be treated first The extremity should be examined for nerve or major blood vessel injury If bleeding is excessive, control it by direct pressure or by tourniquet Look for compounding An open wound should be explored with a probe under sterile precautions to see if it communicates with bone If the fracture is compound, operation is required as soon as x rays are taken Patients with compound fractures should receive prophylactic chemotherapy and careful observation for the development of gas gangrene is indicated If there is no evidence of a compound fracture, a suitable temporary splint (a pillow ham splint Thomas splint, arm or elbow splint) must be applied before the patient is moved for x ray

Fracture of the Elbow

These fractures must be carefully examined for evidence of nerve damage

1 *Supracondylar Fracture* When displacement exists, the lower end of the humerus is displaced posteriorly Reduction is obtained by pulling the lower fragment downward and forward and by acute flexion of the elbow The elbow is held in the flexed position by a posterior plaster slab, held by ace bandages One must observe the radial pulse and circulation of the hand constantly for forty eight hours There is usually a great deal of swelling If any doubt arises as to the integrity of the circulation, the apparatus must be removed at once A person with this type of injury should be hospitalized

2 *Fracture of the Head of the Radius* Slight fractures are treated by simple immobilization in the right angle position with plaster or a right angle splint Complete fractures with marked displacement may be improved by manipulation If not, they require open operation In children it is wise not to remove the head of the radius In adults it may be done safely

Fracture of both Bones of the Forearm

If the fracture cannot be manipulated under anesthesia and locked end to end, open operation is indicated

Fracture of the Wrist

1 *Colles' fracture* is an impacted fracture of the lower end of the radius with or without an associated fracture of the ulnar styloid The lower end of the radius is displaced dorsally and radially Under anesthesia the fracture site is manipulated and the impaction loosened up The distal end of the radius is manipulated into flexion and ulnar deviation following which a cast is applied from the elbow to the ends of the metacarpals with the wrist held acutely flexed and in ulnar deviation The cast may be circular or it may consist of antero posterior slabs held with an ace bandage In two weeks the cast may be changed to the horizontal position In three more weeks the cast may be removed and physiotherapy instituted At regular and frequent intervals the splint is removed for active and passive motion and then replaced The dorsal splint may be dispensed with a week earlier than the volar splint

2 *Fracture of the scaphoid* is treated by applying a cast from the elbow to the ends of the metacarpals with the wrist extended and the thumb incorporated in the cast This cast is to be kept on for

SPECIFIC TYPES OF FRACTURES

(See chapter on Useful Hints in Surgical Diagnosis)

Fractures of the Vertebral Bodies

(See Neurosurgical Disorders)

The diagnosis is suggested by pain in the back after a fall X ray films of the lower back should be routine in all patients who have fallen and fractured a heel If a fracture is present, a careful neurologic examination is done to rule out cord damage If there is none, the patient is kept flat in bed, on boards, without any attempt at correction and allowed to recover from the shock and pain and intestinal distention that often ensues Correction of compression of a vertebral body is usually done slowly and gradually over a two week period by the use of an O'Donnell frame, raising it each day At the end of two weeks, the patient is transferred to a hyperextension jacket, applied on a Goldthwait frame Correction may be done quickly by hyperextending the patient in one of many ways and applying the hyperextension jacket at once

Fracture of the Clavicle

If it is a greenstick fracture, with minimal deformity, a figure of 8 ace bandage support is adequate If the fracture is complete with overriding, the method of choice is the use of a clavicular cross A sling is to be used in either case

Fracture of the Neck of the Humerus

This usually occurs in elderly people and is impacted Unless the deformity is severe, it is wise not to attempt to improve it, but rather accept it as it is The treatment is a sling and swathe, immediate gentle pendulum exercises and then careful but effective physiotherapy

Fracture of the Shaft of the Humerus

Always observe for radial nerve palsy Even if not present, watch for its possible later development The best method of treatment is traction either in a Jones humeral splint, suspended and balanced in bed from a Balkan frame or by the use of a hanging cast If the latter method is used, the patient should sleep in the sitting position These fractures heal slowly

Fracture of the Femoral Shaft

In very young children overhead suspension of both legs with skin traction is the method of choice The pull on both legs must be enough for the buttocks to just clear the bed The progress of healing and position is checked often As soon as callus begins to appear, a spica cast may be applied This is to be kept on until adequate callus is evident

In older children or adults skeletal or skin traction on a balanced Thomas splint is the method of choice If position cannot be made satisfactory by traction, open reduction with plating is the method of choice

Fracture of the Lower End of the Femur

Because of the deforming pull of the gastrocnemius muscle, the knee must be bent and skeletal traction applied through the lower end of the femur or the anterior upper end of the tibia To maintain flexion at the knee one may use a Thomas splint with a Pearson attachment or a Bohler leg frame Traction must be maintained until the fracture holds, at which time it is safe to transfer the patient to a long spica

Fracture into the Knee Joint

If there is displacement, it must be treated by open operation to insure correct restoration of joint surfaces

Fracture of the Upper Outer Tibial Condyle (fender fracture)

If the displacement downward is slight, one has only to immobilize the knee by a light cast from toes to groin This cast is to be kept on in extension for a period of four to six weeks, at which time weight bearing with a Thomas caliper is allowed If the displacement is marked, operation is needed to avoid a severe genu valgum deformity with traumatic arthritis

Fracture of the Patella

If the fracture is incomplete or complete but without displacement, a plaster cast from toes to groin with the knee in extension is the method of choice After four to five weeks the cast is removed, weight bearing with a long caliper may be used and physiotherapy and exercises instituted

If the fracture is simple, complete and with separation, an open operation is indicated The operation may be postponed four to five

eight weeks and then followed by a leather wrist support holding the wrist extended The time the wrist support is worn is determined by x ray evidence of healing If nonunion occurs, open operation and bone grafting is usually done

Fracture of Ribs

(See Thoracic Surgery)

Watch for hemothorax and pneumothorax Treat by using one wide adhesive tape completely encircling the base of rib cage, ap plied in full expiration

FRACTURES OF THE LOWER EXTREMITY

Fracture of the Hip

Fractures of the hip are suggested by shortening of the leg, marked external rotation and pain at the site of fracture After temporary splinting, anteroposterior and lateral x ray films are taken The normal hip is x rayed in slight abduction and 15 degrees internal rota tion If hip nailing is indicated, place a marker over the midline of the greater trochanter to determine the length of nail to be used

1 *Intracapsular fracture* (neck of the femur), because of slow healing, is best treated by nailing This must be done quickly, before the patient's general condition deteriorates The nailing is done in the operating room The hip is reduced by the Leadbetter or Whit man method and anteroposterior and lateral x rays are taken If good position is achieved, a 3 inch incision is made over the greater tro chanter and the nail, whose length has been previously determined, is passed up through the neck into the head, guided by x ray films taken as it passes Postoperatively, the patient is kept in Buck's extension to overcome muscle spasm incident to the operation A Balkan frame and trapeze is provided The patient is encouraged to lift the body and change position often The patient may sit in a wheel chair within a few days Weight bearing ought to be delayed at least twelve weeks

2 *Intertrochanteric Fracture of Hip* There are several satisfactory methods of treating this fracture If a nail is used, it is supplemented by a Thornton plate attached to the shaft by screws One may treat this fracture by manipulation and maintaining posi tion by skin or skeletal traction for six to eight weeks with the leg suspended in a balanced Thomas Splint If a Bohler frame is used, traction is obtained by a Kirschner wire through the lower end of the femur

the Herman method Whichever method is used, the following corrective procedure must be done

The heel is manipulated to break up impaction The heel is compressed from side to side with a heel clamp to correct the spreading and widening of the heel which is usually present, then the angle between the body of the os calcis and the subastragalar joint is re stored to its normal angle by skeletal traction A cast is then applied from toes to groin, with the knee flexed 45 degrees and the foot in moderate equinus

DISLOCATIONS

Cervical Spine

Dislocations of the cervical spine are rare They may be accom panied by minor or major fracture They follow violent sudden flexion and rotation The articular facet on one side of the vertebra above moves forward and slips down over the one below There is pain muscle spasm and fixation of the head in an abnormal attitude, such as rotation toward the opposite shoulder Root pain or muscular paralysis may be present If the displacement is bilateral, the head is forward and the chin is locked X ray films through the mouth and in the oblique and lateral planes are required If manipulation by flexion, rotation and extension (Walton method) or by steady trac tion in extension (Taylor method) fails, traction by skull tongs is applied Extreme care must be taken to avoid cord damage Reduc tion is followed by immobilization in plaster or a brace for several weeks or longer

Shoulder

The diagnosis is suggested by pain after a fall, inability to move the shoulder and squaring of the shoulder The commonest type is anterior or subglenoid Posterior dislocations are rare All dislocations should be x rayed before and after reduction to be sure there is no associated fracture Observe for damage to the brachial plexus Damage by manipulation should be avoided if possible Reduction is done under anesthesia by the Kocher method or by simple traction with pressure in the axilla so as to lift the head upwards The arm is immobilized for one week This is followed at once by active and passive physiotherapy

Acromioclavicular Dislocation

This diagnosis is suggested by the prominence of the outer end of clavicle after injury Unless an x ray film is taken with the patient

days to allow swelling to subside The fragments may be approximated with fascia lata, wire or heavy silk Following the operation a cast and splint are used as for incomplete fractures

If the fracture is badly comminuted, it is best to remove the patella to avoid traumatic arthritis

Fracture of the Tibia and Fibula

If only the tibia is fractured, there can be little displacement, no overriding and no fear of shortening Accordingly, it suffices to immobilize the leg in plaster from toes to groin It is wise to flex the knee 45 degrees

If the fibula and tibia are fractured in a transverse fashion and the ends are in apposition or can be so held after manipulation, a cast is used If the fractures are oblique, one has a choice of two methods open operation or skeletal traction with the wire through the lower end of tibia or the heel, using a Thomas splint Traction is maintained until alignment is good and there is sufficient fusion to allow transference to a cast

Fracture of the Ankle

1 Simple fracture of the fibula without displacement requires a short leg cast from toes to knee, with the foot in the right angle position A walking iron is incorporated and walking allowed This cast is removed in five weeks

2 *Simple fracture of the internal malleolus and lower end of fibula* without displacement requires a short cast extending from toes to knee with the foot in inversion and at a right angle A walking iron may be added in two weeks and weight bearing allowed This cast ought to be on for a minimum of six weeks

3 *Fracture of the Ankle with Displacement and Dislocation of Foot* This fracture must be manipulated under anesthesia and the foot held in inversion and right angle position The cast must extend to the groin with the knee flexed slightly If satisfactory position has not been obtained, open reduction is indicated

Fracture of the Os Calcis

Because of the marked swelling usually associated with this fracture and the hemorrhagic blebs which may develop correction of the fracture is postponed a week or ten days, during which time elevation is used to reduce swelling At the proper time the heel fracture is treated by the use of the Bohler frame and heel clamp or by

standing, it may not be disclosed Treatment Place a pad over the clavicle and apply adhesive strapping over its outer end, pulling the strapping down and around the elbow and forearm to hold it down Traction over the clavicle by a piece of rubber tubing attached to a shoulder spica is another method

If conservative treatment fails, the disability can be corrected surgically by excising the outer third of the clavicle

Elbow

The forearm usually dislocates posteriorly Severe damage is not common Dislocation is corrected by pulling the forearm down and into flexion Immobilization ought not to last longer than ten days Physiotherapy is started early

Semilunar Bone of the Wrist

This is suggested by pain over the anterior surface of the wrist and inability to extend the fingers Immediate manipulation under anesthesia is performed With the wrist extended, pressure is put on the dislocated semilunar with sudden flexion of the wrist Immobilize the wrist in flexion for three weeks and follow by physiotherapy If reduction is unsuccessful, open operation is done through an anterior approach If more than two weeks have elapsed, the semilunar bone should not be replaced, but excised

Dislocation of the Phalanges

Reduction may require open operation

Dislocation of the Knee

Dislocation of the knee is rare Anesthetic manipulation is required With traction applied, pressure on the tibia will restore position A cast is applied and then split to avoid circulatory damage Long immobilization is required because of ligamentous tears A knee cage is worn after the cast is removed



Fig 29 A Fracture of the right clavicle
B Subcoracoid dislocation of humerus Arm abducted Axis deviated inwards Shoulder flattened
C Axillary dislocation of humerus Arm greatly abducted Axis deviated inwards more than in adjoining cases Shoulder bulged by a large hematoma (De Quervain Clinical Surgical Diagnosis 4th Ed John Bale Sons & Danielson Ltd)

ally follows trauma to an extremity, a burning or tingling pain over shadows the vasospastic element, which seems to involve the arteries of the brachial or lumbosacral plexus so as to produce defects in nerve conduction Since the large vessels are not involved in causalgia or in Raynaud's disease, the vasospasm will not be reflected in oscillometric readings

ARTERIOSCLEROTIC DISEASE OF THE LOWER EXTREMITIES

Clinical examination of the legs for chronic arteriosclerotic vas cular occlusion requires a minimum of apparatus Persistent de ficiency of flow produces a thin, shiny, transparent, smooth skin on the feet The nails become striated and opaque One or both feet will show a cadaveric pallor on elevation above the horizontal with a speed proportionate to the deficiency of flow When the feet hang down they assume a cyanotic rubor Rubor in any position with or without a cyanotic hue is indicative of capillary stasis rather than good flow, if the skin is cool or cold rather than warm, and if blood returns slowly after blanching by finger pressure

The absence of pulsations in the major arteries is of no telling diagnostic value because circulation may be adequate in the absence of pulsations A pulsating dorsalis pedis or posterior tibial artery is almost never present in arteriosclerotic vascular occlusion This is almost equally true for the popliteal The femoral artery is usually patent, even if pulsation is reduced in vigor Oscillometric readings in the lower leg will be slight or wholly absent

Since the increasing deficiency of flow progresses slowly, the nat ural demand for collateral supply, stimulated by the deficit in flow, has been satisfied as fully as possible, so that little or no vascular reserve by vasodilatation remains These patients, accordingly, will seldom show a rise in skin temperature on blocking sympathetic impulses

From the foregoing it is obvious that a proper appraisal of the state of the peripheral circulation in chronic arteriosclerotic oc- clusive disease can be made by physical examination alone Occasion ally it is useful to assess the degree of relief that might accrue from eliminating pain of visceral origin, i e , pain arising within the vessels themselves Sympathetic denervation is sometimes helpful for this purpose but eventually the somatic pain of dying tissues predomi nates and the sympathectomy can be justified only in the unusual case in which a residuum of reflex vasodilating capacity still remains It is, therefore, in order to test the prospects of relief of pain and im

CHAPTER 25

PERIPHERAL VASCULAR DISEASE

VASOSPASTIC DISORDERS

These include Raynaud's syndrome, scleroderma, livedo reticularis, acrocyanosis, the reflex effects of cervical rib or the scalene syndrome, embolism, thrombophlebitis, Sudeck's atrophy, causalgia and the reflex effects of trauma

Functional vasospasm occurs in *Raynaud's disease,* which is a psychosomatic disorder of females that most overtly affects the digits It may involve other parts, including viscera In Raynaud's disease, the digits are usually no warmer than the environment and they become white or cyanotic and painful as a result of emotional stress or fall in environmental temperature While nearly all persons register a decline in blood flow in the extremities on exposure to sufficient emotional strain, the temperature of the digits at other times is well above environmental temperature It is possible that scleroderma like Raynaud's disease, is initiated or at least aggravated by severe psychic tension While a properly performed sympathectomy in Raynaud's disease is effective, the patient requires psychotherapy because the emotional factors continue to disable other areas not amenable to surgery In the less advanced cases surgery may be obviated by proper psychotherapy

Regional vasospasm, sufficient even to threaten viability or more commonly to greatly reduce the functional capacity of the limb occurs in response to direct injury to arteries or veins or as a result of embolic occlusion or thrombophlebitis of the deep veins Persistent but milder degrees of vasospasm occur in the so called reflex sympathetic dystrophies (1) In *traumatic arthritis* of the ankle (Sudeck's atrophy) or of the wrist elbow or shoulder In the latter condition the vasospasm is accompanied by hyperhidrosis and osteoporosis (2) In association with injuries of the spinal cord (poliomyelitis, the disk syndrome) or peripheral nerves (cervical rib syndrome) In the latter condition the vasospastic factor is not so obvious on the surface pain occurs on effort because of restricted blood flow in the regional musculature In *causalgia,* which gener

Tetraethylammonium bromide blocks all sympathetic ganglia, while procaine is selective but less prolonged in action "Dibenamine" or "priscol" may prove to have some usefulness for the same purpose

As a rule, the results of sympathetic block are discouraging and one is reduced to the following conservative regimen

1 Careful hygiene of the skin and nails
2 Avoidance of use of the legs sufficient to elicit pain
3 Keeping the legs "at the angle of circulatory sufficiency"—slightly below the horizontal—in the position of optimum color
4 Keeping the feet unwrapped so as to lower metabolic demand
5 Whisky may be given for its analgesic and vasodilating effect, if there is no contraindication to its use If there is severe pain, try a more or less continuous intravenous drip of 5 per cent alcohol in saline
6 A Balkan frame with overhead handle bars
7 Buerger's exercises These are performed as follows (a) Elevate the legs until the toes blanch (time must be determined for each patient) (b) Hang the legs over the edge of the bed for three minutes (c) Rest flat in bed for two minutes (d) Repeat this cycle for thirty minutes out of as many hours as it is comfortable for the patient When elevating the legs constitutes a considerable effort or is otherwise contraindicated, the exercises should be restricted to hanging the feet over the edge of the bed for three minutes once every fifteen to thirty minutes

These exercises are intended to elicit reflex vasodilatation by intensifying the ischemia They are contraindicated in the presence of infection Their value is dubious, except perhaps as a kind of mild occupational therapy

The great variety of apparatus and drugs calculated to improve flow by inducing reflex vasodilatation have proved useless Intravenous saline, testosterone, pancreatic extract, nitrites, nicotinic acid, papaverine, intravenous ether, tetraethylammonium bromide typhoid vaccine etc , are of no demonstrable enduring value in peripheral arteriosclerotic disease

Heat in any form is likely to be harmful since the resulting elevation of metabolic activity increases the demand for blood which cannot be satisfied There is, in fact, some basis for doing the reverse, i e , depressing the existing level of metabolic activity by the application

provement of flow by novocain block of the lumbar sympathetic trunk (see below) or by the administration of such drugs as tetraethylammonium bromide

Special Procedures

Oscillometry measures the amplitude of pulsation in the larger vessels and may be used to verify the presence of pulsation when its presence is in doubt, and to mark the location of major arterial obstruction It indicates patency of large vessels It does not measure blood flow *Arteriography* is useful to show the general pattern of vessels, especially in the case of an abnormal communication, but it does not measure flow rate It may be helpful occasionally to distinguish between organic block and vasospasm The rate of diffusion of intra arterial injections of *radio-sodium* into special areas may be used as a rough gauge of the effects of therapeutic technics

Under normal conditions almost all the blood flow in the toes is through the skin, in the foot the flow through the skin is one half that in the deeper tissues, but in the leg the flow through the skin is probably not more than one fourth that in muscle An increase in skin temperature, induced by removal of vasoconstrictor impulses, measures the increase in blood flow of skin, but does not reflect the extent of increase in the muscles The most reliable test of the degree of improvement in flow through muscle is the functional one of the reduction of pain and the increase in exercise tolerance before and after sympathetic nerve block

Lumbar Sympathetic Block

Expose the lower extremities to room temperature for about thirty minutes Avoid cross currents of air Take skin temperature measurements with a thermocouple at selected points on both extremities Paravertebral novocain injection is then performed by the introduction of a 4 inch needle at the junction between the lowest rib and the lateral border of the erector spinae muscles When introduced directly forward at this distance from the midline, the needle will avoid the transverse process and will come in contact with the body of the vertebra Inject 10 cc of 1 per cent novocain The needle is then partially withdrawn and directed more laterally so that it strikes and then slides off the outer aspect of the vertebral body Inject another 10 cc of 1 per cent novocain, first making sure that the needle is not in a blood vessel Skin temperatures are then read every five or ten minutes for one hour Even if the skin temperature of the injected side does not rise, the skin should become dry

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of cooling agents or at least exposure to cool room air Deterioration of tissue integrity to the point of producing gangrene by the unwise application of heat is a familiar clinical experience

Denervation of the extremity for relief cannot be performed by crushing or alcohol injection of the sensory nerves above the ankle, because incisions at this level will not heal, while complete denervation at a higher level—the sciatic trunk and the internal saphenous nerve—produces a flaccid, useless extremity

If intravenous alcohol fails to relieve the intractable pain in the more advanced cases, demerol, metapon or opiates are given until amputation becomes inevitable

The *local lesion* on the toes or feet in this disease is not substantially improved by local applications The best type of local care for the uninfected lesion consists in keeping the lesion dry by applying a sterile dusting powder and covered by a well aerated occlusive dressing, with the toes spread apart by sterile glass wool fiber If there is infection, parenteral chemotherapy and uncapping or drainage may be required Antiseptic ointment and wet dressings are more likely to do harm than good, but topical antibiotics may be worth while

The indications for amputation are (1) the onset of more or less continuous pain at rest, signifying progressively increasing deficiency of flow, (2) chronic sepsis, which is advancing in spite of the foregoing therapy, including antibiotics, (3) necrosis or gangrene of one or more toes Diabetic patients with a circulation that is still reasonably good may suffer local necrosis and gangrene as a result of infection Local amputation or amputation posterior to the heads of the metatarsals will often prove feasible, if combined with chemotherapy

Amputations

The site of amputation must be one at which there is sufficient blood flow to permit primary wound healing This level is usually supracondylar and occasionally between the middle and upper third of the lower leg The latter level, which is far better for functional restoration of the limb, is usually impossible in arteriosclerotic gangrene, but it is frequently possible in Buerger's disease If the patient is diabetic the problem is more difficult because the wound may become infected if there is sepsis in the foot already

If spreading infection is present even in a nondiabetic patient, it is hazardous to perform a closed amputation, even if combined with massive chemotherapy A guillotine amputation is then performed

3 or 4 inches below the site of election, to be followed some weeks later by the definitive procedure

Nearly one third of the deaths following amputation are due to pulmonary embolism from the same or opposite leg Prophylactic ligation of both femoral veins, therefore, is done routinely at the time of amputation

Avoid the use of a pillow under the thigh after the first twenty four hours following a low thigh amputation, in order to prevent a tendency to flexion deformity Get the patient up on crutches early and order a temporary peg leg before the patient leaves the hosiptal A peg leg is an inexpensive light apparatus which permits early activity and quicker rehabilitation

Painful Amputation Stumps Neuromas, if present, are ex cised only if pain is localized and if local anesthesia relieves the pain Pain of a causalgic nature is treated by sympathectomy If sweating and coolness are also present, the benefit from sympathectomy will be greater If limb pain is untreated for a long time, it may develop an anxiety state which occasionally might be suitable for prefrontal lobotomy, although this is not as yet an established procedure

The psychic trauma at the prospect of an amputation is great Psychiatric therapy is desirable before and after operation Such patients derive considerable reassurance if they are enabled to ob serve and talk with a well adjusted amputee Elderly patients, as a rule, remain chronic invalids, whether one or both extremities are lost eventually, for they seldom adjust themselves to a prosthesis

THROMBOANGIITIS OBLITERANS

Victims of this disease are younger than those with arteriosclerosis They may give a history of phlebitis migrans

The general principles of therapy described above apply to this condition also In addition, there is general agreement that smoking is definitely harmful in thromboangiitis obliterans, because of its vasoconstrictor effect, and should be prohibited Gangrene of toes or of a localized area of the foot in this disease does not carry the same risk of spreading infection or progressive necrosis as does arteriosclerotic gangrene Severely damaged feet can often heal and become useful Even when amputation seems inevitable, it may be avoided in many instances Because a large element of the ische mia is due to reflex vasoconstriction, which is rare in arteriosclerosis, lumbar sympathetic ganglionectomy is frequently worthwhile Healing of chronic ulceration is not infrequently facilitated Sympa

thectomy may not only improve flow, but may also relieve pain due to ischemia

If sympathectomy is not done, pain can be temporarily relieved by crushing the five sensory peripheral nerves to the foot above the ankle One will find that when pain seems confined to a limited area, nerve block of that area will not suffice The less intense pain in other ischemic areas is no longer masked, and it will be necessary to go on anesthetizing more and more until the whole foot is numb The incisions made for this purpose will usually heal In arteriosclerotic gangrene this cannot be done because such incisions will frequently not heal

If amputation is done, it is frequently possible, and always desirable, to perform it at a level 6 inches below the knee

PERIPHERAL ARTERIAL EMBOLISM

Arterial embolism is nearly always of cardiac origin It usually occurs at the bifurcation of a large artery The most common symptoms are sudden pain, coldness, numbness and occasionally hyperesthesia of the affected extremity The pain is due to ischemia of the affected part Pain at the site of the embolus is caused by spasm, tension and inflammation of the adventitia Rarely, patients are observed without pain

The objective evidence of embolism is sudden pallor, anesthesia, collapsed superficial veins, tenderness at the site of occlusion, loss of reflexes, varying degrees of muscular paralysis and loss of position sense Pulsation is felt somewhat below the actual obstruction, but is absent or faint in the distal part of the extremity Though there is a fall in temperature in the obstructed portion of the extremity, hyperthermia may occur at the level of the vascular occlusion

Peripheral arterial embolism should be suspected in any cardiac patient who has sudden pain in an extremity which shows pallor, coldness and loss of pulsation The differential diagnosis between massive deep venous thrombosis with reflex arterial spasm and peripheral arterial embolism rarely offers difficulties Oscillometry will show pulsation if the ischemia is due to venous thrombosis Early diagnosis of peripheral arterial embolism is imperative, since the life of the extremity may be saved by early treatment

The bifurcation of the common femoral is the most common site of lodgment of an embolus but also the most accessible one when surgical therapy is required

An embolus often produces more block than is expected because of reflex spasm of collateral vessels and branches The embolus may change from a partially obstructing saddle type at a bifurcation to a completely obstructing one more distally Secondary thrombosis at the site of embolism may develop rapidly and involve nearby tributaries Since damage to the intima of large arteries occurs easily, removal of the clot, unless performed very early, is followed by immediate reformation of a new clot or thrombus Therefore, if evidence of spontaneous improvement is not manifest within a few hours, operation (embolectomy) should be undertaken Operation is not often successful after the first eight hours An embolus to an upper extremity rarely requires operation because of the better collateral circulation

For embolectomy, local or spinal anesthesia is best The incision in the artery is made through normal arterial wall, below the embolus Heparin solution 1 1000 in saline is used to irrigate the arterial wound A running stitch is used for closure Parenteral heparin should be given after embolectomy for several days even though a hematoma may form

If operation is not advisable, heparin should be started at once to stop propagation of thrombus and to forestall deep venous thrombosis, which is a common complication

Medical measures to aid the circulation include sympathetic block and intravenous papaverine (0 06 gram every two hours for four doses, then every four hours until the circulation is improved) for the relief of spasm

While waiting for collateral supply to develop, cold applications (ice bags or packs) to the ischemic extremity may preserve the tissues by lowering the demand for blood If the circulation is not restored, amputation is indicated A period of delay is advisable before amputating, to allow demarcation of the necrotic area Sympathectomy may be done during this period of delay to permit more conservative amputation

The mortality is high whatever is done This is often the result of the cardiac disorder or of subsequent emboli

Arterial occlusion may also result from traumatic severance, compression from adjacent disturbances (fracture, tumor, hematoma) or reflex spasm which persists long enough to induce thrombosis If sufficient flow through the vessel or through collaterals remains to prevent frank necrosis, atrophy with fibrosis sufficient to produce fixation deformities (Volkmann s ischemic paralysis) may follow

If an artery is severed, apply a tourniquet only if it is impossible to control the hemorrhage otherwise If the vessel has only a lateral laceration it may be preserved by suture If a vessel requires ligation, it should be divided between ligatures so as to avoid reflex vasospasm of the collaterals, which may follow ligation in continuity The companion vein should also be ligated and divided in order to avoid the ready by pass which a relatively increased venous capacity would create As in the case of embolism, if there is any question of survival of ischemic tissues of an extremity, sympathectomy or frequent sympathetic block may facilitate recovery Partly ischemic but surviving tissues should be mobilized early to prevent fibrotic fixation and atrophy Other physiotherapeutic measures such as massage and whirlpool baths may be needed

Recent developments in surgical technic (grafts of veins or arteries) make it possible now and then to restore the continuity of major vessels

Frostbite The trauma of prolonged exposure to cold consists of a loss of tissue integrity as a result of local circulatory damage The weight of evidence indicates that damage to capillaries results in the escape of virtually whole plasma into the tissue spaces of the involved area, leaving behind a red cell sludge which occludes the vessels, with subsequent ulceration or gangrene in advanced cases The fibrin deposited by the extravasated plasma leads to fibrosis and severe disturbance of function in muscles and tendons Heparinization, soon after injury, is said to help clear the vessels of agglutinated red cells, reestablish blood flow and so facilitate wound healing No local treatment is indicated except aseptic protection of denuded surfaces, perhaps supplemented by local or parenteral antibiotic therapy Sympathectomy may be tried in severe cases

ARTERIOVENOUS ANEURYSM

Arteriovenous Fistula

In the congenital type the communications are multiple and so extensive as to make surgical correction difficult or impossible In the acquired or traumatic type a cure can nearly always be achieved unless excision of the vessels will result in unwarranted damage The signs and symptoms on the whole are what may be expected in such a disorder

Local signs The superficial veins near the fistula are dilated and tortuous, the pressure in them is elevated and the venous oxygen content is elevated Since the parts supplied by the artery distal to

the fistula receive less than their normal complement of blood, they show varying degrees of circulatory deficiency, e g , in the lower extremities intermittent claudication, ulceration or gangrene of the digits, etc Edema near and distal to the fistula is due to the elevated venous pressure The skin temperature is increased near the fistula and subnormal distal to it A "machinery" murmur, loudest during systole, is easily heard near and for a variable distance from the fistula, but the accompanying thrill may not be palpable except directly over the site of the fistula The artery and vein proximal to the fistula and the vein distal to the fistula are dilated, the artery distal to the fistula is smaller than normal Collateral vessels in the neighborhood are enlarged because the distal ischemia induces maximal vasodilatation

Distant effects Compression or obliteration of the fistula slows the heart rate by a vagal reflex The increased pulse pressure resulting from the decreased resistance at the by pass reverts to normal on compression and obliteration of the fistula

The size of the fistula determines the extent of the increased load on the heart Cardiac output is always increased The heart is nearly always dilated to some degree and in some long standing cases hypertrophied as well In advanced cases with large fistulas, congestive heart failure may occur The blood volume may also be increased But an exact parallelism between the local disorder and the changes in the central circulation is not always found

Therapy Both central and local disturbances are eradicated by successful repair of the fistula This usually requires extirpation of the fistula The technical problem involved in achieving this is sometimes formidable and occasionally impossible As a rule, the fistula will not be cured unless the artery and vein above and below it are ligated and the intervening mass of involved vessels removed The latter is essential because smaller vessels entering at or near the fistula will take over and reestablish the original pathologic condition A fistula between the internal carotid artery and a vein cannot be so treated Nor is it safe to extirpate the common carotid even in young subjects Transvenous closure of the fistula or infolding of the sac may occasionally produce a cure One may be compelled to limit the surgical effort to a proximal ligation, and even this may be impossible in the case of large vessels in the mediastinum If the artery is ligated and the fistula removed three or four months after establishment of the fistula, gangrene is not so likely as it is if the procedure is attempted immediately after the trauma, because a substantial collateral supply will have developed by that time The danger of gangrene

can be reduced by compression of the artery several times daily for several weeks in advance of operation, to encourage development of collateral supply Sympathectomy provides an additional safe guard

Cirsoid aneurysms and pulsating angiomas are essentially arterio venous aneurysms Vascular nevi, congenital telangiectases and angiomas may be converted to painful vascular tumors of a kindred nature by trauma Only radical excision will cure them, but the surgical procedure may prove hazardous because of the danger of severe hemorrhage The magnitude of the problem as a result of widespread involvement may preclude surgical attack on the lesion

Hemangiomas which cannot be excised because of resulting excessive mutilation can sometimes be improved or eradicated by repeated local injections of a sclerosing solution

Glomus tumors are exquisitely tender tumors, very small in size, superficially located, e g , in the subcutaneous fat or beneath a fingernail They are collections of nerves and small vessels that are cured by simple excision

Aneurysms result from infection (lues), trauma (bullet) or arteriosclerotic degeneration They may be slow to develop even if due to trauma and in the early stages may not be detected unless auscultation discloses a bruit Since the pathology and treatment of aneurysm differs from that of arteriovenous fistula, a correct differentiation is essential This can be done by taking note of the fact that there is a distinct pause between the systolic and diastolic phases of the bruit in aneurysm, whereas in arteriovenous fistula there is a continuous thrill and machinery like bruit, accentuated in systole In aneurysm the bruit may be heard only in systole The heart does not enlarge the veins around the lesion do not dilate and the trophic changes from deficient flow which occur in arteriovenous fistula do not occur in aneurysm

An aneurysm is not an emergency condition unless it is increasing rapidly in size or has ruptured An effort should be made to develop collateral circulation before surgical cure is attempted This is done by periodic compression of the artery proximal to the aneurysm several times a day either manually or by a Matas compressor and by sympathetic block or denervation The aneurysm should be excised if it can be done without risking survival of the tissues affected If this cannot be done as in the case of large vessels like the common carotid innominate or iliac, an endo aneurysmorrhaphy or an intrasaccular closure of tributaries leading into and out of the sac may be performed Excision of an arterial segment can

sometimes be repaired by a bridge in the form of a vein graft Proximal ligation is sometimes effective, but this is not a reliable procedure If the aorta is involved, electrocoagulation and wiring may be attempted When a traumatic aneurysm is repaired, an associated nerve injury, if present, should be repaired at the same time

VARICOSE VEINS OF THE LOWER EXTREMITY

Varicose veins arise as a result of valvular incompetence Many people are congenitally predisposed to this deficiency, but the effect of gravity, repeated straining, chronic cough or any other force which persistently or repeatedly increases venous pressure in the saphenous veins is the precipitating factor The first appearance of varicose veins in women is most often during or after a first or subsequent pregnancy, as might be expected The first valve to give way, as a rule, is the one at the saphenofemoral junction Others yield in turn, so that the normal venous pressure is increased in the standing position to some 75 mm of mercury and may rise to 275 mm of mercury on straining The saphenous vein becomes elongated and, therefore, tortuous and there is a successive involvement of tributaries So long as the deep system functions, the flow in the varicose saphenous system is caudal and into the deep system via the perforators If the valves of the latter remain competent, all the blood in the sitting or erect position returns via the deep system by virtue of muscular compression and the sucking effect of inspiration Visible edema does not occur and aside from the disfigurement of the varices, there may be no symptoms, except perhaps an occasional mild discomfort from local venous tension Nevertheless, the veins in this stage are a proper subject for surgical correction since cure can often be achieved, whereas neglect is all too often followed by progressive involvement of the perforators In this relatively simple stage the treatment consists in ligation and division of the vein and its tributaries close to the saphenofemoral junction Since this procedure only reduces the increased pressure due to straining, but does not decrease the pressure while standing, it does not always suffice to effect a permanent cure If the varix is very extensive, even while the perforators are still competent, more certain cure involves, in addition to ligation, an excision of the main trunk down to the middle of the lower leg by the stripping technic

If the process has progressed so as to destroy the valvular competence of the perforators, blood through such perforators no longer moves from the superficial to the deep system, but in the reverse

direction The result is venous stasis, edema, increasing pigmentation of the skin, nutritional deficiency and finally ulceration, usually precipitated by local trauma

The main perforators, which are the cause of the more advanced varieties of varicose veins, are found at fairly constant positions The first is a large vessel connecting the femoral vein in Hunter's canal with the main subfascial tributary of the saphenous vein in the thigh It will be found about 15 cm above the knee The next one is just proximal to the adductor tubercle and a third is the external saphenous vein, which connects the popliteal vein with the internal saphenous in the lower leg

Tests for incompetent perforators are performed as follows With the patient lying supine, the foot is elevated The veins are thus emptied A tourniquet is applied *tightly* just below the head of the fibula and the patient then stands quickly Normally the veins below this tourniquet fill with blood which flows through capillaries Such filling takes from twenty five seconds to a minute or more In the absence of an arteriovenous aneurysm, filling of these veins in less than twenty five seconds is due to incompetent perforating veins in the lower leg If these veins are competent, the prognosis for surgical cure is excellent

The same test is repeated with the tourniquet just above the knee Rapid filling of the veins below the knee means an incompetent perforator in the fascia distal to the tourniquet or of the external saphenous as it perforates the fascia in the popliteal space

A tourniquet is then applied high on the thigh, just below the saphenofemoral opening and the test repeated Rapid filling suggests a major incompetent perforator at the level of Hunter's canal Finally, while standing, the tourniquet in the upper thigh is released Rapid or immediate filling indicates incompetence of the valves at the saphenofemoral junction Nearly every patient with varicosities or symptoms caused by venous back pressure has incompetence at this level

Varicose Ulcer and Phlebitic Ulcer

The differential diagnosis of these two conditions is essential because the treatment is radically different *Phlebitic ulcer* is not readily amenable to cure as a rule, since the underlying pathologic condition is not eradicable Only occasionally will excision followed by grafting be permanently successful If there is much vasospasm, sympathectomy may be helpful Varicose ulcer, as a rule, can be cured unless large numbers of incompetent perforators below the knee

are present Both types of ulcer are usually located in the same area Phlebitic ulcer is accompanied by extensive edema and chronic in duration, varicose veins may or may not be present as a compensatory phenomenon and there is a history of deep phlebitis In varicose ulcer varicose veins are always present There is no pronounced fibrosis of the neighboring tissues Venography will help to distinguish the two conditions

A *varicose ulcer* is an irreversible lesion, which can be kept from progressing by maintaining a compression dressing over it so as to occlude the veins congesting the area, but this is no final answer to the problem A steady increase in tissue breakdown, secondary infection and chronic disability will result Cure requires, in addition to ligation and stripping of the saphenous trunk, the identification and obliteration of involved perforators

Sclerosing therapy for varicose veins without surgical treatment is worthless, since recanalization will occur Retrograde injection of sclerosing solution at the time of operation may facilitate stripping, but this may be harmful since the chemical solution can produce inflammation in the valves of the communicating veins and of the deep femoral system

The *operation for varicose veins* is facilitated by previously marking out the course of the dilated veins with a suitable dye, such as acroflavin, red ink, Parker 51 ink or eyebrow pencil

Though local anesthesia is often satisfactory, general or spinal anesthesia is required for most patients

The passage of a long instrument, such as a uterine sound, down the lumen of the vein will allow easy location of the saphenous trunk above or below the knee

The perforator in Hunter's canal is best reached by extending the groin incision downward Large separate masses of varicosities can be dissected out separately Numerous incisions may be necessary to carry out the stripping procedure Though the procedure appears unsurgical and may give rise to brisk temporary bleeding, which can be diminished by elevation of the extremity and by applying pressure, the operation, even when extensive, is very well tolerated Walking is desirable and possible the day after operation

If the perforators are competent, the operation is limited to ligation and division of the saphenous vein and its tributaries in the groin Spontaneous retrograde thrombosis usually occurs in some degree Remaining open varicosities can then be obliterated with intermittent small injections of sclerosing agent Five per cent sodium morrhuate solution, solutions of soapy compounds and 5 per cent

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quinine in urethane are satisfactory sclerosing agents From ½ to 2 cc of the latter is used, depending on the size and length of the vein to be obliterated The injections are done at weekly intervals They should be made in the recumbent position only

Surgical treatment of varicose veins is contraindicated (1) when varicose veins in the upper thigh and groin communicate with many veins in the pubic region, especially in the vulva, (2) in patients of advanced age with arteriosclerosis and fibrosis of the soft tissues and (3) when they develop as a sequel to deep thrombophlebitis

Patients with varicose veins, who require operation for lesions elsewhere, are predisposed to the occurrence of thrombophlebitis of the deep veins of the lower extremities To avoid this complication, bilateral femoral vein ligation at the time of or before operation usually will prevent embolism Whether or not this is done, early ambulation is a worthwhile prophylactic procedure because the incidence of deep venous thrombosis will be decreased, though not eliminated In some cases prophylactic anticoagulant therapy may be used, beginning some four to five days postoperatively

Chronic thrombophlebitis of the deep veins can be relieved by the prolonged and repeated application of compression bandages (elastoplast) Ligation of the superficial femoral vein, with or without excision of the saphenous vein, is said to facilitate the healing of phlebitic ulcer The hazard of aggravating the edema by this procedure is considerable

CHAPTER 26

ORTHOPEDIC DISORDERS

THE EXAMINATION OF AN ORTHOPEDIC PATIENT

Most patients who present themselves to the orthopedic surgeon have pain. The type of pain and its distribution, if carefully analyzed, may determine at once whether or not it is of an orthopedic nature. There is a distinct pattern to orthopedic pain. It is usually related to position, posture or activity. If it is radicular in type, it may be made worse by coughing and sneezing. The mode of onset is important. The pain of gout is acute in onset and the patient can remember almost exactly when it began. Infections of joints or bones begin acutely. The presence or absence of injury must be determined. The injury may have been forgotten because it was rather insignificant and may be recalled only after direct questioning.

The clinical features of the condition may be objective or wholly subjective. The objective ones should be obvious: deformities, peculiar gaits and limitation of motion. The subjective ones may need to be dissociated from psychogenically inspired complaints. A large proportion of psychosomatic complaints are related to skeletal structures.

In doing the physical examination one learns a great deal by watching the patient during normal activity. The manner in which he gets out of a chair and his gait are important, particularly in disorders of the low back and lower extremities. The manner in which he removes clothes may be helpful in the diagnosis and may even refute a suspected diagnosis. See how he stands. A quick glance at the feet will determine whether the mechanics of the feet are sound. Observe the pelvis. A lowering of the pelvis on one side may mean a short leg or a structural scoliosis. Make these observations from the front and the back and the side. Palpate the spinous processes to determine the presence of any structural or functional variation from the normal. Ask the patient to bend over. In this position it is easy to see the presence of a gross structural distortion of the spine. All joints, particularly those suspected of having trouble, are put through their ranges of motion passively and gently to determine the presence of

any restrictions due to pain, muscle spasm or adhesions There is likely to be considerable spasm if restriction of motion is the result of pain In the absence of spasm, restricted motion is usually due to adhesions

The comparative length of extremities is important and must be measured Atrophy of muscles may be determined by bilateral measurements at corresponding levels of the extremities

Specific Types of Orthopedic Examination

The Cervical Spine Note the position in which the head is carried If it is carried forward, the patient is susceptible to neck strain Restricted motion of the cervical spine without much acute pain is usually caused by hypertrophic changes If the restriction is severe and associated with muscle spasm or acute strain, injury to ligaments or intervertebral structures is likely

The Shoulder Joint Watch the manner in which the patient removes clothing See if there is any restriction of motion Examination of the shoulder joint involves careful inspection and palpation of the muscles of the shoulder and scapula to determine the presence of atrophy In examining the shoulder proper, hold the scapula fixed in estimating shoulder joint motion In acute disorders, such as acute subdeltoid bursitis, abduction is almost impossible in the upright position, but readily performed with the patient bent over and the arm in the pendulum position If adhesive changes are present, motion is restricted in both positions Partial rupture of the supraspinatus tendon is suggested by a wincing pain as the arm is lowered from the elevated position to just below the horizontal A complete tear of the supraspinatus tendon prevents abduction from being initiated, but if the arm is lifted above the horizontal position, the patient can hold it there by use of the deltoid muscle

The Spine Of importance is a list, which indicates protective muscle spasm Observe the lumbar curve If it is reversed or flattened, a pathologic condition deep in the vicinity of the posterior longitudinal ligament the intervertebral disk or a nerve root is likely Restriction of forward flexion with a list to one side or the other usually indicates injury to deep ligamentous structures, e g , nerve root impingement due to a displaced intervertebral disk In this situation sciatic pain may or may not be present Hyperextension usually is restricted by the same disturbances which produce a reversed lumbar curve Lateral motions should be observed Restricted chest expansion associated with rigidity of the spine suggests spondylitis of the Marie Strumpell type

The Hip Move the involved hip through all ranges of motion Tenderness over the greater trochanter suggests trochanteric bursitis Flexion deformities are elicited by flexing the opposite thigh on the abdomen so as to flatten out the lumbar spine This allows one to determine the presence of an adduction or flexion deformity Look for atrophy of the buttocks

The Knee Observe for atrophy of the quadriceps muscle, the presence of thickening of the capsule, fluid, instability of the knee joint by anteroposterior or lateral motions of tibia on femur Tenderness of the joint line should be noted Weight bearing and foot mechanics affect the manner in which the knees are used Pain and tenderness over the internal lateral ligament is a result of pronation of the foot

The Ankle Joint In the presence of trauma, inspect for thickening, tenderness and ecchymosis in the vicinity of the external lateral ligament

Foot Mechanics Note the presence of tight heel cords, pronation and actual depression of the arch Clawing of the toes associated with a high arch type of foot is important evidence of strain

LOW BACK PAIN FOLLOWING TRAUMA

Muscular sprain is characterized by an acute onset and point tenderness It is of short duration Treatment is by strapping, local application of heat and rest Occasionally novocain injection into the tender area will provide quick relief

Ligamentous strain usually occurs at the lumbosacral joint It is treated by rest, support with a brace and by physiotherapy

Ruptured Intervertebral Disk The diagnosis is suggested by episodes of acute back strain, followed at once, or after two or more attacks, by pain referred into the leg When acute and associated with leg pain, the pain is referred along the sciatic nerve, and its exact reference into the leg is determined by the actual root involved Reflexes may be diminished A diminished or absent knee jerk suggests a lesion of the third lumbar segment A diminished or absent ankle jerk suggests a lesion of the fourth or fifth lumbar segments The patient usually lists and has a flat or reversed lumbar curve Forward flexion is restricted and exaggerates the list Forced flexion causes reference of pain into the ipsilateral leg Hyperextension of the lumbar spine increases pain in the leg The pain is made worse by coughing, sneezing and defecation because of distention of the spinal veins The pain is worse on getting up from the lying and sitting

positions Jugular compression accentuates the pain and straight leg raising is sharply restricted on the affected side Sensory disturbances also occur The diagnosis is confirmed by a myelogram The diagnosis of a similar syndrome in the lower cervical spine is also confirmed by myelography An elevated spinal fluid protein is contributory evidence

Conservative treatment (1) Rest in the position of flexion—semi erect position in bed with pillows under the knees (2) Heat to the back (3) Traction to the affected side by Buck's extension (4) Sedation (5) Plaster jacket, if needed

Surgical Treatment

If conservative therapy has failed and if the pain is constant and disabling, operation is indicated Preoperative care is routine The decision whether to fuse the spine after laminectomy for extraction of the disk must be made in advance, since a graft from the tibia or iliac crest will be needed for a fusion One view is that in this disorder one is dealing fundamentally with an unstable spine and that the ruptured disk is probably the most overt manifestation of this instability Others hold that the instability is a sequel to rupture of the disk Whichever is the case, fusion is becoming more and more popular, especially in patients whose work requires much bending or lifting The end results are better in patients with fused spines

The conventional type of fusion with an osteoperiosteal graft may be done, or a block of bone may be used to fuse the spinous processes Postoperatively the patient is kept on a firm mattress and rolled as a unit from side to side hourly If a bone block fusion has been done, the patient is kept constantly in the extended position to avoid displacement of the graft, which is locked by extension

A Taylor brace or a light removable plaster jacket is fitted The patient with a graft from the iliac crest or bone block from the tibia may be up in about three weeks If a large tibial graft has been taken for the fusion, it is best to wait another week or two to avoid fracture of the weakened tibia The brace or jacket is used for eight to ten weeks and is then followed by a short low back brace, either the Brackett or Goldthwait type, for another six months Exercises are then given to mobilize the spine

AFFECTIONS OF THE SHOULDER

Acute subdeltoid bursitis with calcification usually begins abruptly with severe pain, after a prodromal period of minor pain

There is inability to abduct the arm and acute tenderness over the subdeltoid bursa An x ray film reveals calcification in the bursa Treatment is by a sling, ice bag, pendulum exercises and sedation Novocain infiltration may then be tried This may be accompanied by irrigation of the bursa, using large needles In persistent cases incision and drainage of the bursa is done

Adhesive bursitis is more properly called *adhesive capsulitis* It has a gradual onset and there is no history of trauma Marked restriction of all motion is present and x ray films show no disorder Treat by physiotherapy, including active and passive stretching of spastic muscles In obstinate cases the shoulder is manipulated under anesthesia, and this is followed by exercises and physiotherapy until the arm can be fully abducted to the vertical position

Ruptured supraspinatus tendon occurs usually following a direct blow It may or may not be associated with a dislocation The diagnosis is suggested by a history of trauma associated with little pain, but with subsequent inability to abduct the shoulder from the dependent position and inability to sustain passive abduction when the arm is 45 degrees or less from the side Point tenderness over the greater tuberosity is present Treatment is by operative repair as soon as the diagnosis is established

Recurrent Dislocation of the Shoulder Joint Chronic dislocation of the shoulder joint is believed to be due to congenital failure of development of the glenoid, particularly its anterior edge, or to incomplete healing of capsular tears The early dislocations are produced by substantial trauma Eventually, as the condition progresses, the arm may be thrown out of place by the slightest movement and the dislocation may occur even during sleep The conservative treatment is to wear an elastic shoulder cap The commonest surgical treatment is the Nicola operation (or a modification of it in which the tendon is not divided), which utilizes the long tendon of the biceps to hold the head of the humerus in place Other procedures create an artificial enlargement of the anterior lip of the glenoid, strengthen the capsule by reefing, or hold the humeral head in place by a fascial sling anchored to the scapula

CONGENITAL DEFORMITIES

Club foot or *congenital talipes equinovarus* is a deformity noted at birth, in which the foot is turned in, with four elements of deformity plantar flexion of the ankle inversion of the foot, adduction of the forefoot and medial rotation of the tibia Treatment

should be started early It consists in the use of corrective casts applied every two weeks with progressive correction of each of the deformities After the feet are corrected, which takes two to four months, a Dennis Brown splint may be used with the foot directly attached to the plate of the splint or with prewalker clubfoot shoes attached to the splint

Cervical Rib This may produce symptoms at any age, but usually at about the age of thirty Symptoms are caused by pressure on the adjacent cords of the brachial plexus or on the subclavian artery A tight *scalenus anticus muscle*, a congenital anomaly of the first rib or a cervical rib may produce the same clinical manifesta tions The symptoms may be due to compression of the subclavian

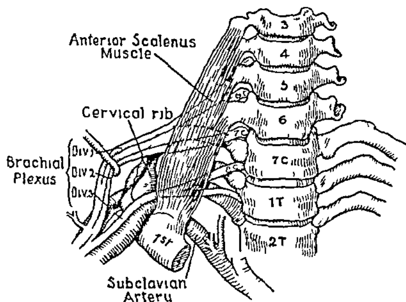


Fig 30 The effect of the scalenus anterior muscle on the lower cords (After Adson in Mercer Orthopedic Surgery 2d Edition William Wood & Co Baltimore)

artery beneath, especially when the patient elevates the chin or turns the head to the affected side In so doing, one may notice weakening or obliteration of the radial pulse The resulting effects are vasomotor changes, cyanosis, ulceration or gangrene of the finger tips Symp toms due to pressure on the brachial plexus are pain on motion of the shoulder, on turning of the head or during exercise, paresthesias and muscular atrophy Diagnosis by x ray is not always conclusive Conservative treatment should be attempted first It consists in keeping the arm abducted in an aeroplane splint and developing the accessory muscles of the shoulder to overcome the postural droop of the shoulder, which precipitates the symptoms In stubborn cases the scalenus anticus is divided and the cervical rib, or an abnormal first rib, if present, may be resected

Congenital Wryneck This is due to unilateral contracture of the sternocleidomastoid muscle, with secondary shortening of the fascia and other muscles of the side of the neck It may be detected in the first few weeks of life, when it manifests itself by a mass in the sternocleidomastoid muscle The mass is tender If treated at this stage with gentle massage and twisting of the head in such a manner as to stretch the muscle, the secondary contractures may be avoided If not detected early, contracture, tilting of the chin toward the op posite shoulder and rotation and tilting of the occiput toward the same shoulder develop If allowed to progress without therapy, asymmetry of the face develops In late cases treatment consists in division of the muscle, which is usually done at the sternoclavicular attachment In females a mastoid incision is used to divide the mus cle at its upper end Following operation a correcting Buckminster Brown splint must be worn to hold the divided muscle in the over stretched position

Congenital dislocation of the hip joint is a partial or complete displacement of the head of the femur due to a developmental defect of the acetabulum The disorder is first recognized as the baby's gait displays growing instability There is a limp that becomes a waddling gait, the leg is shorter than it should be, there is a positive Trendelen burg test and the femoral vessels are difficult to palpate The x ray film shows the smaller epiphysis displaced outwards, and may show foreshortening of the neck and a shallow acetabulum If the diagnosis is made early, simple abduction on a mattress splint or an adjustable abduction splint is used The acetabulum may then quickly restore itself to normal If the condition is discovered after the child begins to walk, the hip must be reduced by manipulation and held by a cast in the frog position for two to three months The position is then shifted progressively during the next three months Neglected or uncorrected cases require operative reduction by shelf stabilizing procedures

BONE DISEASE DUE TO DEFECTS IN CALCIUM PHOSPHORUS METABOLISM

Rickets is due to a deficiency in vitamin D It is characterized by bowing of the long bones, enlargement of the joint surfaces, prominent parietal and frontal bosses, excessive perspiration and a prominent abdomen The x ray appearance is diagnostic If recog nized early, vitamin D and sunshine will arrest the disease and de formities will correct themselves with growth Well established old deformities may have to be corrected by surgical procedures

Scurvy results from vitamin C deficiency It may cause among many manifestations subperiosteal joint hemorrhages and pain referred to the long bones Vitamin C is curative

Fibrous Dysplasia of Bone (Osteitis Fibrosa Disseminata—Albright's disease) This syndrome is of unknown etiology and is characterized by (1) spotty bone lesions which show osteoblastic as well as osteoclastic activity, (2) cutaneous and buccal pigmentation and (3) precocious puberty in females The bone and cutaneous lesions tend to be on the same side and are segmental in distribution The serum calcium and phosphate are normal, so is the urinary excretion of calcium The serum alkaline phosphatase, however, is always elevated The tendency to spontaneous fracture and to sarcomatous degeneration is great

Osteopetrosis (marble bone) is a rare disease of bone associated with increased density of the skeleton The bones lose strength The cause is unknown, it may be familial There is evidence that the condition is related to disturbance of the parathyroid glands There is no known treatment

Osteomalacia (adult rickets) is usually the product of starvation and deficient absorption of calcium and phosphorus The bones show marked rarefaction, become deformed and fracture spontaneously The x ray findings are marked decalcification with deformities or fractures The blood shows a low serum calcium with or without a low phosphate The serum phosphatase is increased Treatment consists of vitamin D, a high calcium diet, sunlight and measures to prevent or correct deformities

Osteoporosis resulting from disuse atrophy will correct itself when the involved area is reactivated in a patient who is properly nourished Generalized osteoporosis occurs not only in hyperparathyroidism and in women beyond the menopause because of severe estrogen deficiency, but also in younger adult women whose ovaries have been removed or in premature ovarian failure If estrogen lack is responsible for the disorder, treatment includes one mg of stilbestrol or 1 25 mg of "premarin" daily together with 200 mg of vitamin C to facilitate the metabolism of the estrogen, and a large calcium intake (milk, cheese or calcium gluconate tablets) As much as 5 mg of stilbestrol has been given in severe cases

Paget's disease may be generalized or confined to a single bone The disease radiologically is characterized by a worm eaten appearance with alternating areas of condensation and rarefaction The bones thicken and may bow Blood calcium and phosphate are normal There is no treatment Sarcomatous degeneration may occur

Parathyroid Osteodystrophy (See Endocrine Disorders) A parathyroid adenoma may produce a profound disturbance of calcium metabolism characterized by diffuse rarefaction of bones, irregular in type, with absorption of the compact bone and with cyst-like degeneration Fractures may result from minimal trauma The bone lesions produce pain The serum calcium is high and the serum phosphate is low Metastatic deposits of calcium may occur in various tissues, especially in the renal pelvis Treatment requires search for and removal of the parathyroid tumor

CYSTIC DISEASES OF BONES

Bone cyst occurs in the long bones in children The etiology is unknown The cyst shifts to the end of the shaft with time Spontaneous fracture may occur If the fracture is well placed and complete, healing may cause obliteration of the cyst The serum calcium is normal Treatment is surgical—curetting the cyst and packing it with bone chips

Post-traumatic Osteodystrophy (Sudeck's Atrophy) This condition is most common in the wrist and ankle It is characterized by pain, stiffness, vasomotor disturbances and atrophy of bone It usually follows minor trauma or fractures X ray films show extensive atrophy, which is possibly related to a disturbance in the autonomic nervous system Sympathectomy provides immediate relief Repeated paravertebral block may help Under physiotherapy the lesion in many cases may disappear

TUMORS OF BONE

Benign Tumors

Osteoma is found at the ends of the shaft When large enough, it interferes with muscle function and then may be removed

Chondroma is a slow growing tumor arising from the cartilaginous elements of developing bone The osteochondroma, a combination of osteoma and chondroma, is more common Surgical removal is done if it interferes with function or if it is unsightly

Giant cell tumor starts at the epiphysis As it grows, it destroys adjacent bone trabeculae The tumor may expand eccentrically or it may widen the bone and then break through the cortex It produces pain swelling and deformity Eventual fracture may occur The x ray film shows enlargement of the end of a long bone by a clear multicystic swelling Treatment is either surgical (curettage) or x ray therapy It is unwise to combine both forms of treatment

Hemangioma of bone is a painful lesion, most common in vertebral bodies The x ray findings are typical, the vertebral body shows vertical striae If allowed to progress the lesion may break through the cortex and impinge on spinal roots and even the spinal cord Fortunately the tumor is radiosensitive

Malignant Tumors of Bone

Periosteal fibrosarcoma is an extracortical lesion with secondary changes in the bone due to pressure erosion The tumor remains encapsulated a long time The x ray film reveals a faintly outlined soft tissue shadow Excision must be complete If not, recurrence locally with eventual metastasis is likely

Osteogenic sarcoma is a rare tumor, usually occurring in the second decade of life It arises in the long bones, especially in the lower end of the humerus and the upper end of the tibia Pain is an early symptom, while swelling is a late manifestation, but symptoms may be absent Occasionally direct trauma precedes the onset of the tumor The diagnosis is suggested by pain of recent origin associated with swelling at the end of a long bone in a young adult Osteolytic and osteoblastic changes appear in the roentgenogram and in well developed cases vertical striae of bone extend into the tumor mass The treatment is amputation, preceded by intense, almost destructive radiation

Endothelioma (Ewing's tumor) is a tumor in adolescents or young adults, occurring in the long bones The disorder starts with pain, fever and leukocytosis The x ray film shows diffuse rarefaction, expansion and thickening of the cortex by deposits of subperiosteal bone arranged in parallel layers called "onion layers" The treatment is amputation and x ray therapy

Multiple myeloma is a rare disease in adult life characterized by pain fever and the development of masses of varying size in ribs, sternum vertebrae, pelvis and femora as well as elsewhere The tumor is either a plasmocytoma, lymphocytoma, myelocytoma or erythroblastoma Multiple circumscribed areas of destruction appear in the roentgenogram The total plasma protein is elevated The viscera may be involved Treatment is by x ray therapy, but this is unsatisfactory The stilbenes are said to be helpful

Septic Joints

Joints may be infected by extension via the blood stream from another focus or by direct involvement from trauma, such as a compound fracture, or from a neighboring osteomyelitis Local pain

swelling, spasm, increased joint fluid, fever and signs of systemic infection are present The diagnosis is made by examination of aspirated fluid Treatment consists in splinting and traction, chemotherapy, repeated aspiration of the joint with local instillation of appropriate antibiotics Finally, orthopedic measures to restore function are needed Surgical drainage is not indicated unless chemotherapy and a conservative routine are ineffective

Tuberculosis of bones is insidious in onset, steadily but slowly progressive, associated with swelling, pain and local wasting Eventually pus extends periosteally and tracks along fascial planes so as to produce an accessible cold abscess The roentgenogram shows destruction and attempts at repair by bone proliferation The diagnosis is aided by the tuberculin test, culture and guinea pig inoculation of aspirated fluid or exudate The treatment is rest, heliotherapy and immobilization in a cast, aspiration of the cold abscess or surgical intervention Streptomycin, 0 5 gm daily, is helpful

Tuberculosis of the spine is a disease of young children It may originate in the epiphyseal plate, body or other portion of the vertebra If unchecked, compression and destruction of vertebral bodies, with cold abscess formation and cord damage may result Treatment consists of general measures and apparatus to prevent or correct kyphosis Fusion of the spinal column may be performed

Tuberculosis of joints begins, as a rule, in childhood and is often secondary to tuberculosis elsewhere Trauma may precede it The onset is slow and insidious There is slight swelling, fluid in the joint, muscular atrophy and pain The diagnosis is difficult at first The only x ray finding in early cases may be atrophy of the bone Aspiration and examination of joint fluid is helpful A low sugar level in the fluid is suggestive In late stages x ray films show destructive changes The diagnosis may be made by arthrotomy and biopsy Treatment General measures, immobilization until fusion occurs Streptomycin, 0 5 gm daily, facilitates the healing of excised sinuses and the performance of surgical arthrodesis

EPIPHYSEAL DISTURBANCES

Slipped Upper Femoral Epiphysis This condition occurs in heavy children between the ages of ten and seventeen and is believed to be due to an endocrine disturbance Trauma may play a part in its production It is more common in males than in females in a ratio of five to two There is pain in the anterior aspect of the hip, radiating down to the knee It is usually associated with a limp As the condition progresses, there is limitation of abduction and internal

rotation, and eventually limitation of hyperextension and full flexion Prior to actual slipping, the diagnosis is rather difficult The x ray film sometimes shows a little blurring of the epiphysis As the con dition progresses, it is easy to recognize, because the film shows a downward rotation of the femoral head This may progress to com plete separation of the head If the slipping is minimal, the treatment may be either freedom from weight bearing by the prolonged use of a nonweight bearing caliper brace or operation for fusion of the epi physis by hip nailing If the slipping is more than minimal, open operation followed by hip nailing must be carried out

Osteochondritis deformans coxae juvenilis, or Legg Perthes disease, is a deformity of the femoral head resulting from a disturb ance of growth of the epiphyseal cartilage, chiefly in boys between five and ten years of age The earliest symptom is a limp with or with out pain There may be spasm, limitation of abduction, internal rotation and flexion The x ray film reveals flattening of the femoral head The neck expands and shortens and its metaphyseal end rounds off Treatment requires either prolonged rest with traction during an acute episode, or walking with a nonweight bearing Thomas splint with a pattern bottom and a high built up shoe on the other side Progress of the condition is observed by repeated roentgeno grams

Kohler's disease of the tarsal scaphoid occurs in young children between the ages of three and six The symptoms consist of pain, swelling and tenderness in the region of the scaphoid The pain is worse on bearing weight The x ray film reveals condensation of the scaphoid Treatment requires rest, usually best obtained by the application of a cast for four to six weeks

AFFECTIONS OF THE KNEE JOINT

Rupture of the Semilunar Cartilages The internal semi lunar cartilage is usually ruptured by a force which internally rotates the lower leg on the femur, while the knee is in flexion This is caused by stepping into a hole or by being struck on the side of the knee It occasionally occurs when getting up from the squatting position The diagnosis is suggested by sudden acute pain associated with in ability to extend the knee fully and by the development of synovitis and tenderness over the medial aspect of the knee joint If the tear is minimal, the condition quiets down within a few days If blood or fluid distends the joint, relief from the discomfort they produce is provided by aspiration It is soon possible to extend the knee and it is not necessary to do anything except to apply a restricting band

age If the cartilage has been torn so that the knee does not extend completely after several days, one may employ other procedures to effect a cure Manipulation of the knee, either with or without anesthesia, is sometimes effective in reducing the displaced semilunar cartilage If this procedure is effective, the knee is immobilized in a plaster cylinder for a period of two or three weeks This is followed by physiotherapy If the knee cannot be extended after a reasonable time, it is then advisable to operate and remove the cartilage This is also done when a cartilage, previously torn, repeatedly buckles and disables the joint

Tears of the external semilunar cartilage are relatively rare The indications for treatment are the same as for the internal cartilage

In individuals who are employed in dangerous occupations, such as roofers and iron workers, it is wise to operate on minor tears of the semilunar cartilages

Osteochondritis Desiccans In this condition a fragment of articular cartilage, with or without subchondral bone, becomes separated at characteristic sites on the articular surfaces of certain joints the elbow, ankle, hip, head of a metatarsal and especially the knee joint Trauma may be a factor The symptoms are those one would expect with a loose body in a joint—locking followed by synovial reaction and disability The treatment is surgical removal

Pellegrini-Stieda's disease is a characteristic calcium deposit in the internal lateral ligament of the knee joint in adult males following trauma There is limitation of motion and tenderness over the medial condyle The diagnosis is made by x ray films The treatment comprises immobilization, physiotherapy and occasionally excision of the calcified nodule

Rupture of the Cruciate Ligaments These ligaments are injured only by severe forms of trauma The diagnosis of rupture of the anterior cruciate ligament is made if the tibia can be displaced forward when the knee is extended A rupture of the posterior cruciate ligament is diagnosed by the ability to displace the tibia backward when the knee is flexed Rupture of both cruciate ligaments produces marked anterolateral instability

Treatment is immobilization in extension for at least two months, followed by physiotherapy and the wearing of a knee cage If this fails, operative correction is attempted

Cysts of the Semilunar Cartilages Cystic swellings in relation to the semilunar cartilages are seen rather commonly Little is known regarding their etiology They vary in size, are multiloculated, and are attached to either the medial or lateral semilunar cartilages

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CHAPTER 27

PLASTIC SURGERY

The basic principle upon which this specialty rests is the transplantation of tissue This often entails multiple stage procedures The technical aspects are less difficult than the plan of procedure, which requires lengthy experience

General Principles

Homografts include preserved cornea, cartilage, skin and bone Relatively fresh cornea may be transplanted from one individual to another Cartilage, after it has been stripped of its perichondrium, preserved in aqueous zephiran and saline solution and refrigerated for an indefinite period, may be used to build out contours and to lend support when buried subcutaneously in another individual The graft may be used in a large, single contoured piece or in smaller particles as desired

Homografts of skin become lost to the recipient after a few weeks, except in the case of identical twins They may be employed as a temporary covering for denuded areas in a critically burned patient

Homografts of bone are also useful Bone removed under sterile precautions and kept refrigerated like blood in a bank, will remain useful indefinitely for grafting purposes in orthopedic surgery

Autografts Skin, mucous membrane, fat, fascia, muscle, tendon, peripheral nerves, cartilage and bone may be successfully employed

A free graft refers to tissue which is completely separated from its original site and transplanted Its survival depends upon the nourishment which it receives from the recipient area Round and wandering cells, which migrate into the graft, together with rapidly ingrowing capillaries, nourish the graft

Free skin grafts are either (a) thin (005 to 010 inch), consisting of little more than epidermis, (b) intermediate or split thickness (010 to 030 inch), which includes epidermis and a varying thickness of the dermis, and (c) full thickness, which includes the entire thickness of the skin from which the underlying fat has been completely removed

Pedicle grafts are necessary when free skin grafts cannot be employed for the following reasons (1) an unsatisfactory bed upon which to place the graft, (2) further reconstructive bone, tendon or nerve surgery is contemplated and a more suitable surface covering

The treatment consists of compete removal of the cartilage and its attached cyst

FOOT DISORDERS

Hallux Rigidus This is a condition of stiffness of the metatarsal phalangeal joint of the great toe, characterized by absence of dorsi flexion It may be traumatic or arthritic in origin Pain on walking occurs, especially when the attempt is made to dorsiflex the joint for take off For mild disability the treatment consists of message, warm soaks and exercises If this does not help, one may insert a narrow piece of tempered steel between the two layers of the sole Arthroplasty may be done if the condition is severe and if there is much pain

Hallux Valgus This deformity is one of marked abduction of the proximal phalanx of the great toe toward the second toe In its extreme form the metatarsal is in varus position Conservative treat ment consists of properly fitted shoes and methodical manual manipulation to decrease the deformity The best surgical therapy usually is the Keller operation (removal of the exostosis and resec tion of the proximal half of the proximal phalanx)

Morton's Toe is characterized by pain, often rather severe, di rectly under the web between the third and fourth toes It is worse on walking, and may compel the patient to remove the shoe in an effort to relieve the pain Subjective or objective numbness of the adjacent surfaces of the toes may be present It is usually present in women with a high arch type of foot While there is some doubt as to its etiology, it appears to be caused by a traumatically induced nodule of proliferating neurilemmar tissue in the plantar nerve be tween the third and fourth metatarsal heads, where the nerve divides to supply the adjacent surfaces of the third and fourth toes The con dition can be cured by removing the nerve segment involved

The deformity in *hammer toe* is a dorsiflexion of the proximal phalanx, plantar flexion of the second phalanx, and flexion or exten sion of the distal phalanx There is a corn on the peak of the de formity, beneath which infection may occur A corn on the tip of the toe may develop and prevent walking It is usually present in the second toe and results from compression by badly fitting shoes or a hallux valgus or it may be congenital, particularly in a high arch or cavus type of foot Excision of the distal half of the proximal phalanx cures the condition in adults In children repeated corrective manip ulation, combined with wide shoes, roomy socks and a corrective adhesive strapping to the toes, will improve the deformity

Preparation of a Local Site The preoperative skin preparation includes a shave, except for the eyebrows, which are never shaved It is desirable to mark out the hair bearing or the hairless area of donor and recipient sites prior to shaving, so that the transplanted tissue will fit in cosmetically This may be accomplished by applying a colored dye (methylene blue) with superficial pin pricks to outline the area

Granulating wounds should have a wide marginal preparation including shaving, removal of all crusts and debris by cleansing with soap and water, ether and alcohol The granulations themselves are rendered as clean as possible by wet saline dressings changed at frequent intervals Pressure dressings help to prevent edema of granulations and to maintain a flat, well vascularized bed

If the granulations are chronic, it is desirable to cut away the exuberant portion or to excise completely all tissue down to a healthy base and normal tissue margins

If the dermatome is to be used, it is essential that the oil of the skin be thoroughly removed by soap and water and ether One of the common technical faults interfering with securing a good dermatome graft is failure of complete and firm adhesion of the skin to the drum

Surgical Principles

Suture Material Ties should be of the finest caliber necessary to accomplish the purpose for which they are used It is seldom necessary to use larger than No 0000 or No 000 catgut For skin margins No 0000 or No 00000 black silk is adequate It is best to use atraumatic needles with the proper curvature for the particular location at hand Skin margins should not be traumatized by hemostats or large mouse tooth forceps Skin margins are retracted by small, one or two prong, sharp retractors Hemostasis should be complete at the termination of the procedure and skin margins closed without tension Wider undermining may be necessary to avoid tension

Dressings The operation is not complete until an adequate dressing has been placed, the dressing being an important feature of plastic surgery The surgeon usually does the dressing himself The dressing over a free skin graft should be cut to pattern, so that it just covers the graft and the suture line at its margin It is then held in place by adhesive tape A larger dressing may then be used to reinforce the first one and is held in place by a combination of elastic bandages and adhesive Sufficient pressure should be maintained to fix the graft to its bed and obliterate all dead space, prevent bleeding and maintain immobilization

is necessary and (3) the cosmetic objective requires a full thickness of skin and its underlying subcutaneous fat A pedicle graft is partially separated from its underlying bed, but retains an attached base through which it receives adequate blood supply Pedicle grafts may be flaps which retain their original size and shape or may be tubes fashioned by suturing together the skin edges of the flap They may have a unipolar or bipolar base to nourish the flap, but a tubed pedicle almost invariably has a bipolar attachment The advantage of a tube is that it has no raw surface This prevents infection and scarring of the grafted tissue and so lends itself to multiple transfers to remote areas of the body In general, tubes are prepared by means of two parallel incisions through skin and subcutaneous tissue, undermining at the level of the superficial fascial plane, then approximating the skin margins by suturing The donor site is closed either by undermining its skin margins and suturing them for primary closure or by covering it with a free skin graft Before a tubed pedicle graft is ready to have one end transferred to a new site, its circulation must be adequate from either pole

There are times when a flap cannot be elevated in one stage because of inadequate circulation It is then necessary to elevate part of the flap and suture it back in place This is known as a delayed flap, its purpose being to improve the circulation through the base of the pedicle Several "delays" may be necessary in preparing a single flap Usually the time interval between each delay is two weeks

Preoperative Preparation

In addition to the usual preparation it is occasionally important to obtain a neuropsychiatric evaluation of the patient before deciding upon plastic surgery Psychological problems due to cosmetic or functional deformities often become as important as the physical deformity itself Certain individuals may exaggerate minor anomalies and the surgical correction may fail to satisfy the patient Photographs of the initial pathology must be obtained to evalute the functional and cosmetic results after surgery Casts of the deformity occasionally are desirable and in some cases essential for study and to use as a working model This is particularly important where a prosthesis forms a part of the treatment

Successful surgery requires a good state of nutrition It is far better to postpone the surgical procedure until deficiencies have been improved rather than to risk failure Infections, even of a minor nature, play havoc with plastic procedures It is usually desirable to institute prophylactic chemotherapy

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Pedicle flaps need some pressure, but care must be taken to prevent undue pressure across the base of the pedicle Inadequate or excessive pressure may jeopardize the graft

Donor sites of split-thickness grafts are best treated by covering with fine mesh gauze impregnated with petrolatum and by pressure applied by the addition of mechanics' waste or fluffs held by elastic bandages If a pressure dressing is to be used over any part of an extremity, it is best to start at the distal part of the extremity and include the joint above the operative site The extremity should then be elevated

Since motion of a graft upon its bed may result in loss of the graft, plaster casts may be used in addition to pressure dressings, especially for the extremities or in areas on or near joints, the neck and axilla The position of the part in splinting is always extremely important For instance, after grafting the dorsum of the hand, the hand should be splinted in the position of function, with the fingers flexed and the thumb adducted

Grafts involving the flexor surface of joints, such as the popliteal space, should have the extremity splinted in extension to prevent contractnre Flexion can be accomplished after the graft has taken

Dressings are not disturbed until it is necessary to remove sutures, usually on the seventh to tenth day (face—three to four days) If drains are required, they are attached to sutures extending beyond the dressing so as to be removable in twenty four to forty eight hours without disturbing the dressing Immobilization and moderate pressure is continued for a week or ten days after sutures are removed and the suture lines are supported for at least three weeks by fine mesh gauze held with skin cement This will minimize lines of tension and thereby prevent widening of scars

Free skin grafts and donor areas should have lanolin applied locally for several months until such time as the skin becomes soft and pliable and crusts no longer form

Rehabilitation and Reconditioning

No plastic problem should be considered completed until the greatest degree of function possible has been achieved, the tissues returned to normal and the best possible cosmetic result obtained This may require physiotherapy, such as active and passive motion, heat, massage and whirlpool baths Active motion should be encouraged after surgery of the hand Psychiatric treatment may be indicated for an indefinite time

CHAPTER 28

PEDIATRIC SURGERY

THORACIC DISORDERS

ontrathoracic surgery in infancy is concerned largely with congenital Icnditions threatening survival abnormalities of the trachea, esophagus, heart and major blood vessels Later in childhood, surgery of the lungs, pleura and great vessels is done for tumor, cyst, bronchiectasis, abscess, empyema or congenital malformation The child's ability to tolerate pulmonary resection without apparent functional disability is striking

Esophageal atresia and tracheo-esophageal fistula usually occur at the level of the first and second thoracic vertebrae The lumen may communicate with the trachea in the neighborhood of the bifurcation above or below the stenosis Other congenital abnormalities are common

The diagnosis is suggested if the newborn baby becomes cyanotic, shows an excess of saliva or frothy mucus in the mouth and vomits when fluid is offered A soft No 8 F or No 10 F rubber catheter is introduced into the esophagus under fluoroscopic control The introduction of not more than 0 5 cc of lipiodol (barium is not used) will demonstrate whether there is a connection between the upper segment and the trachea A chest film also will show the level of the obstructed upper segment, as well as associated lung or heart pathology X ray examination of the abdomen demonstrates the presence or absence of air in the stomach and intestines, i e , whether or not the lower esophageal segment communicates with the trachea

Surgery is performed, when possible, as soon as the diagnosis is made, to forestall fatal pneumonitis Preoperative care includes pharyngeal aspiration, oxygen inhalation and the intravenous administration of blood and other fluids Increasing experience has demonstrated the feasibility of immediate resection and end to end anastomosis in most cases, with a mortality as low as 10 to 15 per cent

Tetralogy of Fallot

This congenital malformation of the heart accounts for about three fourths of the patients with continuous cyanosis from birth The critical abnormality is the inadequacy of blood flow through the lungs because of stenosis of the pulmonary artery or of the right ventricle just proximal to the pulmonary valve and the diversion into the aorta of blood from the right ventricle through a defect in the intraventricular septum The arterial oxygen saturation is therefore low, occasionally as low as 30 per cent A marked further drop in arterial oxygen saturation occurs after mild exercise The capacity for exertion may be limited to a few steps There is usually compensatory polycythemia, which may be extreme, e g , a red blood cell count of 8 5 million or above or a hematocrit over 80 Cerebral thrombosis is a not uncommon result of the polycythemia

The clinical features include cyanosis, clubbing of the fingers, polycythemia, limited exercise tolerance, normal heart size, a harsh systolic murmur and thrill along the left border of the sternum, a clear second sound at the base, a blood pressure range which is narrow and difficult to measure, an electrocardiogram showing right axis deviation and abnormally high waves in lead II The clinical features are inconstant, however, and therefore often inconclusive The diagnosis is established by x ray and fluoroscopic demonstration of the absence of the normal outline of the pulmonary artery and the absence of normal hilar shadows and pulsations in the lung fields

Treatment If the incapacity is severe, surgery can alleviate the disorder The operation aims at increasing the blood flow through the lungs by diverting arterial blood to the pulmonary artery This is done by an end to side anastomosis of the subclavian, rarely the carotid or innominate, to the right or left pulmonary artery Such procedures cannot be done in adults or young infants The pliability of the child's circulation permits such procedures Failure of the collateral supply may occur if the carotid or innominate are used for the anastomosis The operation is preferably done after the age of two years and before the fifteenth year, but it can be performed earlier if the anoxemia is severe enough to produce marked dyspnea or loss of consciousness The therapeutic effect becomes manifest immediately in the form of increased arterial oxygen saturation The polycythemia also disappears with reasonable promptness

Postoperative control of blood volume red cell count and fluid exchange must be particularly careful to avoid dehydration, cerebral thrombosis or overhydration and pulmonary edema Over two

thirds of the patients are improved * The mortality is about 20 per cent

Coarctation of the Aorta

If the constriction of the aorta involves a long segment of the aortic arch and its branches, there usually is an associated major cardiac malformation, so that survival is limited to a few weeks or months The form of coarctation amenable to surgical correction is a short segmental constriction in relation to the ductus arteriosus or the ligamentum arteriosum, just beyond the origin of the left sub clavian artery Patients with this abnormality are usually entirely well in childhood and are not limited in physical activity More than 40 per cent, however, die between the ages of sixteen and thirty years, because of a dissecting aneurysm or rupture of the aorta proximal or distal to the narrowing, vegetative arteritis or complications of the hypertension, such as heart failure or cerebral hemorrhage

The diagnosis is established by the finding of an abnormal dis crepancy between the arterial pressures in upper and lower extremi ties The pressure in the femoral artery is normally 20 to 40 mm of mercury higher than in the brachial artery If these pressures are found to be equal, a moderate degree of stenosis of the aorta may be suspected If the pressure in the lower extremities is considerably lower or not measurable, a high degree of block exists By the time the patient becomes an adult a considerable degree of systolic and diastolic hypertension in the upper extremities develops and the symptoms, if present, are those associated with hypertension If the collateral circulation is well developed, there may be palpable arteries in the pectoral regions, the axillae and at the tips of the scapulae The chest roentgenogram will show scalloping of the inferior margins of the ribs, due to erosion by enlarged intercostal arteries Evidence of hypertensive heart disease is also present The narrowing of the aortic arch may be demonstrated by diodrast injection via a long catheter introduced into the right ventricle through an antecubital vein or into the aorta via an artery in the upper extremity

Treatment The most promising therapy is the excision of the narrowed segment of aorta with end to end anastomosis The proce dure is satisfactory in the age group from six to sixteen years, but in adults fixation and degenerative changes in the aorta may prevent successful execution of the operation Pulsations become apparent in the lower extremities immediately after operation, but the subsid

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ence of the hypertension in the arms requires ten to fourteen days Flow in arms and legs eventually equalizes

Patent Ductus Arteriosus

The normal ductus arteriosus becomes obliterated within the first twelve weeks after birth in 95 per cent of infants, and in 99 per cent by the end of the first year If it does not close after the first year or two, the shunt may produce no incapacity, but the danger of infection is always present If the shunt is large, development may be retarded and the increased work of the heart may produce cardiac failure Overt heart failure usually does not occur in childhood Patients alive at seventeen years of age with an untreated patent ductus arteriosus have half the average life expectancy

A continuous "machinery" murmur, heard best in the second and third interspaces to the left of the sternum, rumbling in quality, accentuated in systole and fading in diastole is characteristic of the disorder Electrocardiographic and roentgenologic examinations are chiefly useful to exclude other abnormalities Dilatation of the pulmonary arteries or of the left auricle may be recognized by fluo roscopy or an x ray film Catheterization of the heart may indicate increased oxygenation of the blood in the pulmonary artery as compared with that in the right ventricle

The surgical treatment consists of suture ligation and division of the patent ductus This procedure is best carried out in childhood as soon as the diagnosis is made, even though there is no disability, because of the high incidence of complications in the untreated disease The surgical mortality is extremely low The technical prob lems and the surgical mortality are considerably greater in adults, who should have the operation only if disabling complications make it necessary

Other Abnormalities of the Aortic Arch

Other variations in the position of the aortic arch or of its major branches may result in pressure upon a major bronchus, trachea or esophagus *In certain instances a "vascular ring" formed* by aorta, pulmonary artery and primary branches or a reduplication of the aorta, circumscribes and obstructs the trachea and esophagus

The diagnosis may be made by x ray studies of the esophagus and trachea In favorable instances this obstruction may be relieved by dividing or displacing some of the obstructing vessels

ABDOMINAL DISORDERS

Pyloric Obstruction

Pyloric obstruction occurs chiefly in males Vomiting seldom occurs before the tenth day after birth and shortly becomes projectile There is no bile in the vomitus Persistent hunger enables the baby to nurse immediately after vomiting The stools are scanty, weight loss is marked, dehydration and alkalosis are present The stomach may be distended, the remainder of the abdomen is not With one index finger a palpable tumor is detected in the right upper quadrant, especially after nursing or after vomiting A scout film assists in the diagnosis

Preoperative Care Administer 75 to 90 cc of fluid per pound of body weight parenterally every twenty four hours for several days, i e, long enough to correct fluid and electrolyte balance This is done in divided doses of (a) intravenous 10 per cent glucose in distilled water, 10 cc per pound of body weight, plus subcutaneous physiologic saline solution, 15 cc per pound of body weight, or (b) 5 per cent glucose in distilled water and 3 per cent glucose in saline solution subcutaneously, shifting alternately from the pectoral region to the back of the thighs About 5 per cent of patients need blood for anemia or deficient plasma proteins If so, not more than 10 cc per pound of body weight is given at any one time A dose of 25 mg of vitamin C is given daily in the parenteral fluids Because some food does get through the pylorus, the child is fed his formula as usual with 5 per cent cereal

Just before operation a catheter is placed via the nose into the stomach and the arms and legs are wrapped in wadding to conserve heat during operation Ether is the preferred anesthetic

Postoperative Care Give 30 cc of fluid by tube as a feeding every 2 hours as follows two feedings of sterile water, then four feedings of whey, then four of one half whey and one half breast milk, then four feedings with 4 cc less of whey and 4 cc more of breast milk each time, so that the fourth feeding is whole breast milk, and finally four feedings of breast milk, increasing the volume each time by 4 cc After thirty six hours on this schedule, food is given every three hours and is increased until 90 cc of fluid and 50 calories per pound are given daily After ten days, feedings are given every four hours The feedings are given with the baby flat The The infant is picked up and held upright after each feeding for eructation of gas

Immediately after operation 60 cc of 5 per cent glucose is given by rectum and repeated in four hours Two intravenous and two hypo

dermic clyses are given on the first day and one or two of each on the second day, utilizing the formulas described under preoperative care

Peptic Ulcer

Peptic ulcer, through rare, is a well recognized disease in infants and children The medical treatment is the same as for adults Surgery is limited to closure of the perforation or gastro enterostomy for pyloric obstruction Resections are not done



Fig 31 Gastric ulcer in a child of seven

Intestinal Obstruction

Intestinal obstruction in the newborn is due to congenital atresia or stenosis The diagnosis of *atresia* can often be made by the ab sence in the stool of the cells of swallowed vernix caseosa (Farber's test), identifiable by Sterling s gentian violet stain The vomiting begins on the first day of life When this happens a scout film in various positions should be taken Barium should not be used In most cases the block is in the ileum Distention will be present after twenty four hours of life If surgical relief is not provided by the

third or fourth day, death from perforation is likely If anastomosis is difficult or hazardous, ileostomy, followed in two to three days by anastomosis, may be performed Ileostomy alone is fatal in the new born The mortality is very high

The *preoperative care* is as for pyloric stenosis Blood, gastric lavage and chemotherapy are also required

Postoperative care follows the same principles as for adults, except that food should be withheld for a few days more than usual because distention occurs easily Infants with gaseous distention may be relieved by breathing 95 per cent oxygen

Intestinal *stenosis* has a better prognosis than atresia Atresia is often multiple, stenosis usually is confined to a single site Sponta neous perforation is less likely The meconium may contain vernix caseosa cells The signs of obstruction may appear later than the first week of life Short circuiting procedures are more readily per formed in stenosis than in atresia, because the distal bowel is more dilated and better manipulated in stenosis

Appendicitis

Appendicitis in children, if untreated, runs a more rapid and more fatal course than in adults Vomiting is almost always present, where as in adults nausea without vomiting is the rule Frequency or dys uria may occur because the bladder is an abdominal organ in young children and so lies close to the cecum Abdominal symptoms after an acute upper respiratory infection, especially measles, or increas ingly disturbing signs in a child with gastro enteritis, should make one suspect the disease Pain is periumbilical, epigastric or diffuse at the onset

In examining the child be gentle, take time to gain his confidence Warm your hands and begin by looking for immobility of the ab domen and at the type of respiration Palpate gently Begin at a distance from the area of expected tenderness Move your hands slowly Spasm, which will not disappear under sustained manual pressure suggests peritoneal irritation The area of tenderness in appendicitis is not so restricted as in an adult Do the rectal examina tion last

The fever is higher in primary peritonitis (over 39 4° C) than in appendicitis (less than 38 3° C) The respirations are more labored in pneumonia In mesenteric adenitis vomiting is less common, fever is slight or absent, the pain less localized and less intense, and leuko cytosis is uncommon In gastro enteritis fever is slight, the pain is

less severe, less continuous, more diffuse and often accompanied by diarrhea Pyuria is present in pyelitis

The care before and after operation is the same as for adults

Malrotation of the Intestine

Malrotation of the intestine presents itself in two forms (a) In complete rotation of the cecum, with bands causing duodenal ob struction These bands are severed for relief of the obstruction (b) Clockwise rotation of the mid gut due to incomplete posterior fix ation of its mesentery Vomiting is the main symptom and usually the stomach and duodenum are dilated in the scout film Occasionally the involved gut is grossly distended from food decomposition in the closed loop

If these conditions first appear in later infancy or childhood, a history of colic, nausea and vomiting will often be obtained Such patients may have been treated erroneously for celiac disease A barium enema is best not used in babies, but is safe to use in older children Do not give barium by mouth if acute obstruction is pres ent

Mid gut malrotation is usually not recognized until operative disclosure of an apparent absence of ascending and transverse colon and the congested bluish appearance of the small intestine Opera tive reduction of malrotation of the small intestine requires deliver ing the gut to the outside and rotating it counterclockwise until it is entirely unwound Incomplete rotation of the cecum always ac companies this condition, so that the band between the unrotated cecum and the right paracolic gutter must be severed also No at tempt is made to place the cecum into its correct position

Meckel's Diverticulum

If present, it lies between ½ and 3 feet from the ileocecal valve If it proves troublesome, it will do so in infancy most often and in nearly all cases before the age of thirteen It may contain gastric, colonic, duodenal or pancreatic tissue The symptoms are the result of hemorrhage or perforation, a peptic ulcer, intussusception, ob struction from a band or umbilical fistula They may exactly simu late appendicitis, but the pain of diverticulum always begins in the right lower quadrant Massive bleeding of red blood by rectum in a baby otherwise without symptoms is likely to be due to this condi tion If there is umbilical fistula, fecal material may be found If not, radiopaque visualization will distinguish it from the fistula of a patent urachus Roentgenography of the ileum usually fails to detect

a diverticulum It should always be removed when found at operation, even if it does not cause symptoms, because it is likely to give trouble later

Duplication of Alimentary Tract

A duplication of the alimentary tract may occur anywhere from the mouth to the anus The duplication is contiguous with and adherent to the alimentary tract, most often to the ileum, it possesses two muscle layers and is lined by mucosa or epithelium of stomach, intestine or colon and contains mucoid secretion It does not communicate with the intestinal lumen It may cause pain from internal tension, obstruction by pressure upon adjacent gut or by impeding its circulation A mass is usually palpable Surgery is necessary for cure

Swallowed Foreign Bodies

Do not reach blindly into the pharynx with the finger You may push the foreign body into the larynx Put the patient flat with the head and shoulders at a lower level Take a film and remove the object by endoscopic methods If the glottis is obstructed and you cannot get at it, do a tracheotomy at once Foreign bodies can always be passed by rectum, once they get into the duodenum They do not require surgery unless they are pointed or sharp objects which may stick and perforate The latter bear watching by x ray films if they are radiopaque They are not removed unless they lodge in one place for more than three or four days

Intussusception

Intussusception is most common in healthy, well nourished male infants between four and ten months of age, who, following an attack of enteritis or for no apparent reason, suddenly become pale, double up and cry with abdominal pain and in a few minutes appear well again This is repeated and vomiting follows soon thereafter Signs of obstruction appear, bloody mucus is passed by rectum A firm, non tender mass is usually palpable in the right upper quadrant or may even advance as far as the rectum and be palpable there If necessary, anesthesia is used to palpate the mass Barium enema will show obstruction with cupping or a cylindrical shell of barium at the site of obstruction Reduction by air or barium is unsafe because it may be incomplete, with loss of valuable time meanwhile Complete reduction may also be unsafe because a polyp or Meckel s diverticulum may be responsible and be overlooked in the x ray study Surgical

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intervention as early as possible is preferable No mortality should occur if surgery is performed within twenty six hours The farther the mass has advanced toward the rectum, the higher the mortality

Preoperative and postoperative care are the same as for intestinal obstruction

Intestinal Polyps

Intestinal polyps in children usually occur on the posterior rectal wall Bleeding is the usual sign Direct visualization will disclose them A barium enema will be required for more proximal ones Those within reach are best removed under anesthesia via a procto scope with a tonsil snare carrying a high frequency current Diffuse polyposis is treated by resection of the colon and anastomosis of ileum to the rectum, which has been previously freed of polyps

Congenital Megacolon

Malnutrition is common and cardiorespiratory reserve is lowered by the elevated diaphragm Temporary relief may be obtained by the use of drugs (doryl, prostigmine) and by repeated graded dilata tion of the anal sphincter up to a diameter of 1¼ inches In cases in which muscular thickening is not too advanced, resection of both lumbar sympathetic chains or the presacral plexus may be per formed, if spinal anesthesia preoperatively causes substantial re duction in the size of the colon The first lumbar ganglion should not be removed Removal of the hypogastric plexus in males causes sterility and in the female may cause loss of orgasm Obstinate cases with restricted areas of involvement may be treated by a limited resection Cecostomy is sometimes necessary for obstruction No method of treatment can be relied upon for a satisfactory result, but substantial improvement in bowel function can often be achieved by good medical care combined where indicated with appropriate sur gery

Imperforate Anus

The symptoms of this congenital disorder, or modifications of it (stricture, incomplete descent of the rectum, rectovesical fistula, etc), are those of obstruction, which are evident within twenty four hours after birth The degree of descent of the rectum by this time can be detected by x ray visualization of the gas in the rectum, with the baby held vertically in the head down position Plastic procedures upon a rectum which is more than 3 cm above the anal pit require preliminary colostomy, with local plastic repair at a suitable time

later in life This applies also to complicating fistulous tracts to the bladder or urethra Postoperative care requires systematic anal dilatations

Primary Peritonitis

Primary peritonitis usually occurs in children under the age of five The streptococcus is the commonest invader and the pneumococcus next Invasion usually follows an upper respiratory infection The process seldom localizes Infants show a "doughy" abdomen, older ones show the classical signs and symptoms of peritonitis The process is distinguished from secondary peritonitis by a stormy course from the start, with a chill and high fever The picture is confused with pneumonia, but a rapid respiratory rate, a lack of abdominal tenderness and the x ray film help to identify pneumonia A tap of the peritoneal cavity by needle or through a tiny incision is a valuable diagnostic aid Operation should always be done, in addition to giving chemotherapy, because it is difficult to be certain that the process is primary Drainage is useful in any case A ½ inch slit into the peritoneum in the right lower quadrant under local anesthesia (and morphine) will deliver enough pus to identify the type of infection and permit insertion of Penrose tubing for drainage

Iliac Adenitis

Iliac adenitis occurs in children as a primary site of metastatic infection from the leg, perineum or anus, without involvement of the femoral or inguinal nodes There is swelling, tenderness and eventually a palpable mass medial to and below the anterior superior spine and above Poupart's ligament, but well below McBurney's point Most cases subside with chemotherapy, but many will require incision and drainage through an extraperitoneal incision

Patent Urachus and Urachal Cyst

If an orifice is present in the umbilicus, a uriniferous or fecal character will determine whether there is a patent urachus or a persistent vitelline duct Identification is more certain by lipiodol instillation into the sinus A cystogram may also help A *urachal cyst* produces a subumbilical midline mass and is apt to become infected It should be removed, if discovered, before this happens

Omphalitis

Omphalitis occurs as a result of an unhealed umbilical surface The infection may spread through the abdominal wall along the

hypogastric or falciform ligaments or into the peritoneum Prompt chemotherapy is required

Omphalocele

Omphalocele (umbilical eventration) must be repaired promptly because of the danger of rupture and infection Since the peritoneal cavity often is too small to accommodate the mass of extruded viscera, simple reduction and repair is dangerous and often unsuc cessful The best treatment consists in mobilization of skin flaps to cover fully the thin membrane overlying the viscera This will pro vide adequate protection, so that, as growth of the peritoneal cavity proceeds, spontaneous reduction occurs Cure may or may not require subsequent closure of a remaining defect

Hernias

Umbilical hernias in infants often cure themselves spontane ously They should be treated conservatively for about six months by a circular strapping applied so as to relieve the lateral tension of the abdominal wall This is done by two pieces of 2 inch adhesive tape, one with a hole in its center, the other with a tongue, so that the strips can be applied interlaced Tincture of benzoin is applied on the skin and the strips are approximated so as to wrinkle and relax the skin in the mid abdomen The strips are renewed once every week or two If a hernia more than ½ inch in diameter persists, grows larger or causes discomfort, surgical repair is indicated, preferably after the child is over eighteen months of age

Congenital diaphragmatic hernia occurs most often in the posterolateral portion of the left leaf In contrast to hernias of the esophageal hiatus, there is no sac in nine tenths of the cases Ad hesions which are common in the acquired type, are usually not present An x ray film readily confirms the diagnosis, which should be suspected in a baby with bizarre chest signs, including atelectasis and cardiac displacement Barium is unnecessary and may be harm ful The operation is best done within the first two days of life, when the baby's intestine is not yet distended and when surgery is better tolerated than after a week or ten days The operation is performed transabdominally, because the reduced capacity of the peritoneal cavity makes reduction from above hazardous Cyclopropane and positive pressure anesthesia are used because cyanosis is common and because a mediastinal defect often exists, threatening collapse of both lungs If the abdominal incision cannot be closed for lack of

room for the reduced organs, the skin is approximated and a week later repair of the fascia can be accomplished

Inguinal Hernia Incarceration is not uncommon and is most frequent in the first six months of life If the child is examined while the hernia is reduced and if the hernia is not apparent in the erect position, it may be detected by gentle palpation of the inguinal canal, in the axis of the recurrent vessels, which will reveal thickening by comparison with the opposite side Spontaneous cure by closure of the processus vaginalis may occur before the sixth month and is facilitated by a yarn truss If it is not cured by that time, surgery is needed Because of the delicacy of the tissues, operation is best de layed until after the first year, if one can wait

An incarcerated hernia should be reduced, if possible, before operation, by giving morphine, elevating the foot of the crib, applying an ice bag and after an hour or two applying gentle pressure, if needed If, after four hours, reduction is not achieved, strangulation is likely and operation should be done with care to observe viability before the reduced intestine is out of sight Soiling postoperatively is prevented by applying a dressing sealed with collodion and by suspending a diaper from a cradle close enough to the penis to catch the urine

Undescended Testicle

An ectopic testis may require surgery A retracted one generally enters the scrotum sooner or later, nearly always by the time of puberty The undescended ectopic testis is a cosmetic and therefore a psychic liability it is more easily injured than a scrotal testis, it loses spermatogenic function unless it gets into the scrotum, and it may become malignant Surgery is indicated for these reasons and because there is an accompanying hernia in most cases Make sure by repeated examination that the testis is not simply retracted by an overactive cremaster and that it cannot be pushed into the scrotum from above downward

Spermatogenesis will not be lost if the testis is brought down by the time of puberty Since most testes will descend by the time of puberty, gonadotrophins are probably not needed in most cases Even if they effect descent before puberty is reached, there is no special advantage, except where the psychic factor is urgent and important They will not be effective if the ectopic testis is held by adhesions When there is doubt as to whether the testis can descend spontaneously, hormonal therapy should be tried before surgery is done, unless a hernia compels operation anyway An especially use

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SECTION III

Endocrine Diseases and Hormone Therapy

ful place for hormonal therapy is (1) in the Frohlich syndrome, in which the hormone greatly facilitates the orchidopexy and (2) after repair, in case the replacement is not quite low enough down The optimum age for repair is between eight and twelve, unless trouble from an accompanying hernia compels earlier operation About 80 per cent of undescended testes can be corrected In the others, the vascular trunks are too short to permit it (See discussion in chapter on The Prostate, Testes, Thymus)

Imperforate Hymen

Imperforate hymen may produce a large abdominal mass consisting of uterus and vagina distended with the mucoid products of the cervix The hymen needs nicking after the diagnosis is made by needle aspiration At puberty this condition may cause hematocolpos, which is similarly treated

Exstrophy of the Bladder

Exstrophy of the bladder should be operated on between the ages of three and five by bilateral ureteral transplantation to the sigmoid, and excision of the bladder—utilizing a central longitudinal strip of bladder wall as a roof for closure of the epispadias—and repair of the diastasis recti Renal infection need not occur and the functional results are reasonably satisfactory

Malignant Tumors

Embryoma of the kidney, a malignant tumor, is one of the commonest types of abdominal tumor in childhood, appearing most often between the ages of two and three years Its presence as a rule is first disclosed only by its size It presents a fixed mass in the flank that is best treated by immediate excision transperitoneally The diagnosis, though usually obvious, can be confirmed by radiographic study to show displacement of the intestine and distortion of the kidney and ureter

Neuroblastoma is more diffuse than embryoma and metastasizes earlier, especially to bones It is the commonest malignant tumor of the abdomen in childhood and arises in the adrenal or sympathetic nerve tissue in the posterior portion of the abdomen or chest If encapsulated it may be cured It may also disappear spontaneously by hemorrhage and necrosis

CHAPTER 29

THE ADRENAL GLAND

The all pervading importance of this organ in normal and disease states merits some discussion of its pathologic physiology

Pathologic Physiology

Failure of adrenal cortical function produces (1) decrease in the serum sodium concentration to about 100 milliequivalents, (2) increase in serum potassium up to some 10 milliequivalents, (3) decrease in chloride and bicarbonate corresponding to the decrease in sodium, (4) increase in nonprotein nitrogen due largely to the decrease in renal blood flow and in glomerular filtration, as measured by creatinine clearance tests, (5) retention of sulfate, (6) decrease in the formation of urinary ammonia in especially severe insufficiency, (7) hypoglycemia due to the characteristic disturbance of carbohy drate metabolism (a decrease in glycogen storage and hypersensi tivity to insulin), (8) decrease in plasma volume, (9) hypotension, (10) decrease in blood flow, (11) hemoconcentration, (12) fall in basal metabolic rate, (13) achlorhydria, (14) hepatic dysfunction, as manifested by bilirubinemia, elevation of serum phosphatase and retention of bromsulfalein, and (15) pigmentation of the skin and mucous membranes, cause not known

Symptoms and signs develop as a result of the surgical removal of tumors or the destruction of both adrenal cortices by tuberculosis or nonspecific necrosis Asthenia, anorexia and extreme fatiguability occur insidiously or in the form of an acute "adrenal crisis," which is manifested by vomiting, abdominal pain, diarrhea, hypoglycemia and a rise in temperature as high as 40° C

Diagnosis In the majority of cases the diagnosis can be made with considerable certainty on the basis of the clinical examination alone, and can be confirmed by measurement of the blood changes mentioned or by salt deprivation for forty eight to seventy two hours The latter test may within twenty four hours induce a crisis

Further data of value in diagnosis are (1) Measurement of 17-ketosteroid excretion in the urine These steroids originate mostly in the adrenal cortex of males and wholly in the adrenal cortex of

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Further data of value in diagnosis are (1) Measurement of 17 ketosteroid excretion in the urine These steroids originate mostly in the adrenal cortex of males and wholly in the adrenal cortex of

females In Addison's disease the daily excretion is between 1 and 2 mg , whereas normally it is 15 mg in the male and 10 mg in the female (2) Differential leukocyte count Lymphocytosis is char acteristic, since one of the functions of the adrenal cortex is to bring about dissolution of lymphocytes and the release of the globulins which are important in immunity (3) Robinson, Powel and Kepler "Water Test," which is based on the fact that patients with Addi son's disease do not show normal diuresis after the ingestion of large amounts of water

The therapy of Addison's disease during intercritical periods con sists of a high salt, high vitamin, high calorie diet and 4 to 8 grams of sodium chloride in tablets or capsules daily If this does not sustain health, desoxycorticosterone acetate ("Doca"), which influences salt and water metabolism, and 11 dehydrocorticosterone acetate ("com pound A"), which controls carbohydrate metabolism chiefly, are given in daily doses of 2 to 5 mg intramuscularly and 15 to 30 mg intra muscularly, respectively Once the patient has been regulated on this regime, which may require four to eight weeks of observation, and a satisfactory maintenance dose of "Doca" is established, pellets of "Doca" are implanted into the subcutaneous fat through small transverse incisions below the inferior angles of the scapulas Such implanted pellets may be expected to last for from ten to thirteen months

The treatment of adrenal crisis includes (1) maintenance of body heat with the aid of heated blankets, (2) a continuous intravenous drip of 3000 to 4000 cc of 5 per cent glucose in saline (30 to 45 drops per minute) during the first twenty four hours, (3) 25 to 50 cc *whole adrenal extract* subcutaneously, followed by (4) 15 to 20 mg *"Doca"* intramuscularly (5) If the response of the patient is not entirely satisfactory, i e , if shock is still present, give 5 to 10 cc whole adrenal extract subcutaneously every two to four hours and an additional 10 mg of "Doca" intramuscularly eight to ten hours after the initial dose Usually a patient in crisis requires 100 cc or more of whole extract and 20 to 30 mg of "Doca" in the first twenty four hours (6) In the days that follow, the dosage of whole extract and "Doca" is determined by the clinical state of the patient Usually the patient is able to take a high sodium, high carbohydrate, high protein diet plus 4 to 8 grams of additional salt within forty eight to seventy two hours after the onset of crisis and requires only 2 to 5 mg of "Doca" daily (7) Watch carefully for signs of heart failure and peripheral and pulmonary edema during the period that the patient is receiving intravenous fluid The amount of fluid must be reduced

or stopped and "Doca" entirely eliminated at the slightest sign of moisture at the lung bases or the presence of facial or peripheral edema (8) If fever persists for longer than forty eight hours after the initiation of crisis, use large doses of penicillin, up to 100,000 units intramuscularly every three hours, until fever disappears If the patient shows sensitivity or resistance to penicillin, use sulfadiazine in full doses, as patients with Addison's disease tolerate sulfonamides quite well The most common intercurrent infections are due to the hemolytic streptococcus and pneumococcus

Treatment of Surgical Complications in Addison's Disease No patient with Addison's disease should be subjected to major surgery unless there is no alternative Particularly hazardous are acute abdominal emergencies such as acute appendicitis or empyema of the gallbladder, which cause fatalities in most patients despite the most careful preoperative preparation No patient is ready for operation unless the blood pressure, blood electrolytes, hematocrit, non protein nitrogen and blood sugar are at normal levels Even when the surgical situation is acute and immediate intervention indicated, it is wiser to accept the risk of postponing the operation for at least twenty four hours for purposes of preparation than to proceed with an incompletely prepared patient During this period of preparation the patient must receive at least 30 cc of whole extract subcutaneously daily, in divided doses of 10 cc , and 10 mg of "Doca" intramuscularly This dosage of both hormones is continued through the operative day and for two to three days after the operation On the morning of operation a constant intravenous drip of 5 per cent glucose in saline is started and continued for a twenty four hour period or longer if necessary If blood pressure is not maintained during operation, 25 to 50 cc of whole extract must be given intravenously Epinephrine may also be given subcutaneously Local anesthesia should be used wherever possible When general anesthesia is essential, the best choice is gas oxygen and ether Spinal anesthesia and avertin must be avoided Preoperative and postoperative morphine must be used only in minimal doses

HYPERPLASIA AND TUMORS OF THE ADRENAL CORTEX

Nonhormonal Adrenal Cortical Tumors

Symptoms do not appear until the tumor either becomes large enough to be palpable and to exert pressure or until metastases occur Removal of these tumors, if unilateral, requires no special precautions

Hormonal Adrenal Tumors or Hyperplasia

These may produce (1) the adrenogenital syndrome or (2) certain metabolic abnormalities simulating Cushing's syndrome

The symptoms and signs in the first group are pseudohermaphroditism, precocious sexual and physical development, hirsutism, amenorrhea (in females), impotence, changes in the voice and a tendency to sex reversal The nature of the clinical manifestations depends on the sex and age of the patient when the disease develops The rule in children as well as in adults is masculinization of the female and feminization of the male

The findings in the second group are truncal obesity, osteoporosis, hypertension, decreased carbohydrate tolerance, purplish striae, polycythemia, dusky cyanotic discoloration of the skin, acneiform eruptions and a tendency to purpura and ecchymoses

Diagnosis First determine whether the clinical picture is the result of adrenal cortical hyperfunction If such hyperfunction is demonstrated, it is either primary (due to hyperplasia or tumor of the adrenal cortex), or secondary to pituitary disease, such as pituitary basophilism To determine adrenal cortical hyperfunction, the following procedures should be carried out (1) Urinary 17 ketosteroid and estrogen excretion—both are at least double the normal in cases of hyperplasia and many times the normal in cases of tumor (2) Electrolyte levels in the blood—the usual findings are reduction in potassium and chloride, alkalosis, some elevation of the serum sodium (decreased urinary sodium) These changes are opposite to those of Addison's disease and are due to increased secretion of the hormone controlling sodium (3) Glucose tolerance curve—diabetic in type owing to increased gluconeogenesis and decreased utilization of carbohydrate, produced by increased adrenal cortical function (4) Hemoglobin, erythrocyte counts and hematocrit to determine the degree of polycythemia Blood volume is increased Polycythemia is more common in pituitary basophilism than in adrenal cortical tumor (5) X ray films of the skull for possible pituitary tumor, of the long bones for osteoporosis, which is more characteristic of basophilism than of adrenal cortical tumor, of the kidneys and adrenals by intravenous pyelography and perirenal insufflation of air

Differential Diagnosis (1) Pituitary basophilism or Cushing's disease This differs from adrenal cortical tumor in that (a) 17 ketosteroid excretion is normal, (b) electrolyte balance is usually normal, (c) degree of virilization is mild, i e , no enlarged clitoris, no acne, mild hirsutism (2) Arrhenoblastoma of the ovary The clinical

picture is like that in adrenal cortical tumor except that changes in electrolytes, in 17 ketosteroid excretion, in the glucose tolerance test, acne, obesity and ecchymoses are absent, while not infrequently a pelvic mass is present (3) Hyperostosis frontalis interna, characterized by noninflammatory deposits of new bone on the internal table of the frontal, parietal or occipital portions of the skull Most patients with this curious condition show most of the clinical signs of adrenal cortical hyperfunction except for normal 17 ketosteroid and estrogen excretion, normal electrolyte balance and absence of osteoporosis, polycythemia and acne (4) Thymic and pineal tumors Tumors of the thymus and pineal occasionally are associated with clinical changes which are quite indistinguishable from those produced by adrenal cortical tumors The thymic tumors are usually carcinomas and are readily demonstrated by roentgenograms of the chest They are not associated with either the sexual or metabolic changes characteristic of adrenal cortical tumors In pineal tumors there are overt signs of an intracranial expanding lesion in all cases, in addition to the sexual changes Here, too, the electrolyte balance and 17-ketosteroid excretion are usually normal

Treatment The treatment of choice for both hyperplasia and tumor of the adrenal cortex is early operation In the case of hyperplasia involving both adrenal cortices, bilateral subtotal resection is carried out, in the case of unilateral hyperplasia or tumor, a total adrenalectomy is done This usually results in complete cure of the disease, with restoration of normal sexual function and normal habits *provided that surgical intervention has been resorted to before malignant changes have occurred* In cases of malignancy the initial results of removal of the tumor are also good, but the patient shows recurrence of symptoms and signs within six months to two years after the operation Recurrence is signalized by progressive increase in 17 ketosteroid excretion, which usually precedes by two to three months the clinical evidence of recurrence

Preoperative preparation As a rule the overfunction of one adrenal leads to atrophy of disuse of the other To prevent death from adrenal insufficiency after removal of the diseased adrenal, the patient must be given the same therapy outlined for the treatment of adrenal crisis for twenty four hours before the day of operation, on the operative day and for forty eight hours afterwards For two months thereafter the patient must be kept on a high sodium, high-carbohydrate and high protein diet plus 4 to 8 grams of additional salt in enteric coated tablets or capsules

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Ganglioneuromas

These are the most highly differentiated of the sympathetic nerve tumors They are benign, small in size and produce no symptoms They are usually found within the adrenal medulla, but may occur anywhere along the course of the sympathetic nervous system

Pheochromocytoma and Paraganglioma

These chromaffin tumors may arise in the carotid glands or from the medullary tissue of the adrenals or from chromaffin tissue located in the paraganglia on either side of or ventral to the aorta near the celiac plexus These tumors are benign Since they secrete epinephrine, periodic episodes of paroxysmal hypertension, cardiac palpitation, profuse sweating, extreme anxiety and tremulousness, headache, vomiting, glycosuria and vasomotor phenomena occur, identical with what is seen after an injection of a large dose of epinephrine The frequency of attacks varies considerably Years or months may elapse between attacks The factors which precipitate attacks are emotional upsets, unusual physical effort, heavy meals, prolonged fasting, manual manipulation of the tumor mass and unusual positions of the body in which the tumor is compressed The average duration of an attack is one to two hours In about 20 per cent of cases bradycardia rather than tachycardia is present Severe precordial pain, epigastric distress, cramplike pains in the extremities and marked urinary frequency are other unusual features which may be present during an attack

The most striking finding on physical examination is the precipitous rise in the blood pressure from normal levels to over 250 systolic and 110 to 150 diastolic Coincidentally, there occurs pronounced distention and engorgement of neck veins and considerable increase in circumference of the neck Pulmonary edema occurs in about one half the cases Hyperglycemia and glycosuria occur in about half the patients, due to glycogenolysis caused by the outpouring of epinephrine About 5 per cent of patients acquire persistent hypertension and develop retinopathy and cardiac hypertrophy In about 50 per cent of them a mass can be palpated in the abdomen This mass may be the tumor itself or the kidney or liver pushed down by the tumor mass

Occasionally there is persistent moderate elevation of the basal metabolic rate In such cases, during attacks, Graves' disease is difficult to rule out

Diagnosis The complete picture of hyperadrenalism is simulated by no other clinical condition In less typical cases the follow

TUMORS OF THE ADRENAL MEDULLA

Extracortical adrenal tumors are divisible into two large groups tumors of sympathetic nervous tissue (the sympathogoniomas, neuroblastomas and ganglioneuromas) and tumors of chromaffin tissue (the chromaffinoblastomas, chromaffinomas and paragan gliomas), yielding the typical chromaffin staining reaction with po tassium bichromate and extracts which produce pressor effects similar to those of epinephrine

The Sympathogoniomas

These tumors originate in the very immature sympathogonioma cells and hence are extremely malignant They usually occur in intra uterine life or in earliest infancy and metastasize rapidly to the retroperitoneal lymph nodes, liver and bones They are large, soft and hemorrhagic, and the cut surfaces show necrosis Microscopic al y, the cells are arranged in "rosettes "

The Neuroblastomas

These occur in early childhood and are extremely malignant Two groups have been described (1) The Pepper group usually involves the right adrenal and metastasizes largely to the liver, (2) the Hutch inson type is characterized by involvement of the left adrenal and metastasizes to the skull, the skeleton generally and occasionally to the lungs and mediastinal lymph nodes In this group there is swell ing of the skull, unilateral or bilateral exophthalmos with ecchymoses of the eyelids, increased intracranial pressure with choked disk, blindness and a palpable tumor mass in the abdomen The reason for the difference in metastatic spread of these two groups is not clear

Differential Diagnosis (1) Wilms' tumor (embryoma of the kidney) Renal symptoms with hematuria and positive pyelographic findings are usually present This tumor is also highly sensitive to x ray therapy (2) Retroperitoneal lymphosarcoma, also sensi tive to irradiation, usually leads to early ascites (3) Chloroma This is radiosensitive and usually occurs in older individuals with clinical and hematological evidence of leukemia Tumors of the oral cavity and the paranasal sinuses are characteristic of this disease

Treatment Excision of the tumor is usually futile and radio therapy fails to alter the course of the disease However, if the diag nosis is made before metastases occur, surgery should be done

CHAPTER 30

THE OVARIES AND THE FEMALE SEX HORMONES

(See Chapter on Gynecologic Disorders)

Physiology of Menstruation

The anterior pituitary regulates ovarian function by secreting two gonadotrophic hormones, the follicle stimulating hormone (FSH) and the luteinizing hormone (LH) The former stimulates growth of the Graafian follicle, which produces increasing amounts of estrogen up to the time of ovulation, the latter gonadotrophin stimulates the formation of the corpus luteum which produces both estrogen and progesterone High concentrations of estrogen react on the pituitary to decrease the production of FSH In the absence of fertilization, the corpus luteum degenerates and the production of estrogen and progesterone falls rapidly This abolishes the inhibitory effect on the pituitary, which again secretes gonadotrophins and the cycle begins anew

Under the influence of estrogens the uterine mucosa proliferates and at the time of ovulation has reached its maximum thickness Subsequently, with the production of progesterone from the corpus luteum, the uterine glands mature and the secretory phase begins During this phase uterine contractility is inhibited

The fall in estrogen and progesterone concentration results from degeneration of the unfertilized corpus luteum Estrogen is also inactivated, i e , converted to estriol by progesterone Premature decrease or total absence of progesterone (anovulatory cycle) upsets its normal ratio to estrogen and results in cyclic irregularities

The decline in estrogen concentration reduces endometrial blood flow The consequent shrinkage of the endometrial layer leads to buckling of the coiled vessels, with resulting stasis and necrosis of the epithelium Desquamation of this layer and rupture of the vessels leads to bleeding It is believed that a local toxin produces vasoconstriction in these vessels, with release now and then for short periods, during which bleeding takes place More stroma than glandular or vascular tissue is lost, so that the latter two structures project above

ing procedures may be done (1) Intravenous pyelogram (2) Perirenal air or oxygen insufflation (3) 17 ketosteroid excretion to rule out possible tumor of the adrenal cortex, which also produces hypertension, but not of the paroxysmal type (4) Gentle massage over either kidney region Starvation for twelve hours or subcutaneous injection of epinephrine may elicit a typical paroxysm in patients observed between attacks Occasionally cold pressor tests are helpful (5) Skull stereograms, fields of vision and lumbar puncture to rule out the so called "autonomic diencephalic fit" produced by tumors of the third ventricle, with pressure on the thalamus

Treatment Paroxysmal episodes of short duration are relieved by inhalations of amyl nitrite Cure can be produced only by surgical removal of the tumor Surgery must be resorted to in all cases where the clinical picture is strongly suggestive, even in the absence of corroborative laboratory data

The operative approach depends on whether or not the tumor has been localized If there is a single tumor limited to one adrenal, the procedure of choice is the extraperitoneal lumbar incision Where the location of the tumor has not been determined, a transperitoneal approach through a midline ventral incision is indicated for adequate exploration of the paraganglionic chains

The anesthesia of choice is gas oxygen ether Spinal anesthesia should be avoided

Preparation of Patient for Operation (1) Suitable blood and plasma should be available for immediate use to combat shock during the operation (2) Five per cent glucose in saline should be given by continuous slow intravenous drip, beginning two or three hours before the operation and throughout the operative day (3) Adequate supplies of epinephrine and adrenal cortical hormone should be available for immediate use in case of a precipitous drop in blood pressure and development of shock

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the surface The coiled vessels thrombose and new vessels grow out from them to revascularize the middle zone, while the glands regenerate a new epithelium Growth of the endometrium then begins, under the stimulus of a gradually increasing estrogen concentration from follicles being activated by FSH, the secretion of which by the pituitary is resumed during the period of low estrogen concentration

Endometrial regression is never as complete during menstruation as it is after castration, because a minimal estrogen concentration persists so long as the ovaries are present and not atrophic

The blood in the menstrual discharge clots as it leaves the vessels, but a proteolytic agent in the discharge dissolves the clot unless the bleeding is so rapid and profuse that this agent cannot keep pace Hence the discharge of clots signifies excessive flow

In the adolescent girl, estrogen causes proliferation of the ducts of the breast, whereas progesterone controls the development of the secretory elements of the breast In the adult woman, the rise and fall of hormonal levels that accompanies the normal menstrual cycle ordinarily produces only minimal changes in the breast

When pregnancy occurs, the fertilized ovum implants itself in the progestational mucosa and the trophoblasts of the embryo secrete gonadotrophins, which may be the agent that prevents corpus luteum deterioration and menstruation Thus, there are two endocrine phases to the gestational cycle an ovarian and a chorioplacental During the ovarian phase, the corpus luteum continues to secrete estrogen and progesterone at about the same rate as during the progestational phase of the menstrual cycle and the excretion of estrogen and pregnandiol (the excretory product of progesterone) is relatively low The corpus luteum degenerates early in the second trimester The chorioplacental phase then takes over The placental cells produce estrogen and progesterone at a rapidly increasing rate A high level is maintained until shortly before labor and then falls rapidly The chorion produces the gonadotrophins, which rise rapidly during early pregnancy and then decline, at first slowly and then rapidly

The urine of pregnant women is, therefore a rich source of gonadotrophins during early pregnancy and estrogen during later pregnancy It is still utilized as a commercial source of chorionic gonadotrophins, while the urine of pregnant mares is the usual source of natural estrogens Mares do not excrete gonadotrophins, but their blood contains high concentrations during early pregnancy The mare serum gonadotrophins are largely made up of FSH, while those excreted in the urine of pregnant women are mostly LH

The *menopause* appears as a result of ovarian atrophy, which follows upon the exhaustion and disappearance of the follicles The resulting disappearance of estrogen produces the menopausal symptoms The intensity of symptoms parallels the titer of the gonadotrophins, but since this increased titer continues in many women after the disappearance of the menopausal symptoms, the latter cannot be attributed to this hormone with certainty Estrogen administration abolishes the menopausal symptoms, including the affective disorder, even though the basis for the affective disorder may be due more to the psychological trauma of the loss of the reproductive life (fear of financial and emotional insecurity) than to hormonal effects upon the psyche

CHAPTER 31

THE PARATHYROIDS

HYPOPARATHYROIDISM

(Parathyroid Tetany Hypocalcemic Tetany)

The parathyroid hormone is concerned with the excretion of phos phorus and the maintenance of a normal level of physiologically active or ionized calcium in the blood The calcium ion lessens the irritability of all tissue, its effect on neuromuscular excitability and cardiac rhythm is particularly important It also diminishes the per meability of cell membranes and is necessary for the clotting of blood

The following factors are important in determining the concentra tion of ionized calcium in the blood

(1) The amount of calcium absorbed from the gut Such absorp tion is favored by increased acidity of upper intestinal contents and by a high calcium phosphate ratio in the diet Disturbances of fat absorption diminish calcium absorption, since insoluble calcium soaps are formed

(2) The *p*H of the blood, which controls the extent of ionization of calcium The lower the *p*H, the higher the ionizable calcium

(3) Serum phosphate level There is a rough reciprocal relation ship between the blood levels of ionizable calcium and of inorganic phosphate

(4) Vitamin D intake, including the Vitamin D formed by ultra violet irradiation of the skin, which facilitates calcium absorption from the gut

(5) The supply of parathyroid hormone, the first effect of which is to increase urinary excretion of phosphate and then to increase the serum calcium

The causes of tetany therefore, may be listed as follows

(1) Alkalosis Overbreathing, such as from (a) emotional dis turbance, (b) fever, (c) low partial pressure of oxygen in inspired air (high altitudes)

Disturbed acid base balance in blood, as in (a) persistent loss of acid gastric juice from vomiting or tube drainage and (b) excess in gestion of alkali during treatment of peptic ulcer

(2) Low level of ionizable calcium in the blood, due to

a Deficient calcium intake

b Defective calcium absorption, resulting from a persistent alkalinity of upper intestinal contents, excess phosphate intake, disturbed fat absorption (sprue, celiac disease), Vitamin D deficiency (rickets, osteomalacia), or diarrhea

c Excessive demand for calcium, as in late pregnancy and lactation

d High level of serum inorganic phosphate (renal insufficiency with phosphate retention)

e Hypoparathyroidism, which is most commonly seen following accidental removal or injury of one or more parathyroid glands during thyroidectomy The onset may be acute or insidious, the severity great or mild The remaining parathyroid tissue may regenerate sufficiently to carry on normal function or it may degenerate to produce complete parathyroid failure Rarely, hypoparathyroidism occurs spontaneously as a result of infection (monilia or some other organism) or secondary to an inflammatory or neoplastic process of the thyroid gland

The symptoms of tetany are largely due to increased neuromuscular excitability induced by the low level of calcium ions in the blood and tissue fluids They may be latent and manifest themselves only when alkalosis follows emotional or other disturbances leading to overbreathing The earliest symptoms are paresthesias of the scalp, face and extremities, followed by cramplike pains and contractures in the distal parts of the extremities or the abdominal wall In the full blown picture one sees tonic and clonic spasm of the muscles, particularly of the extremities, often of the face, trunk, larynx and diaphragm, and sometimes of smooth muscle, such as of the urinary bladder or gastro intestinal tract Epileptiform seizures may occur Laryngeal spasm causes stridor, even sufficient to cause death from asphyxia

Latent tetany may be demonstrated as follows

1 Chvostek's sign—spasm of facial muscles on gentle tapping over the facial nerve

2 Trousseau's sign—characteristic spasm of the hand after five or six minutes of pressure around the upper arm by a blood pressure cuff inflated above systolic pressure

3 Schlesinger's sign—painful spasm of the leg muscles on flexion of the thigh with the lower leg extended

Treatment of Tetany

1 An acute attack is an emergency, which must be treated promptly and vigorously as follows (a) inject intravenously 10 cc of 10 per cent calcium chloride, (b) subcutaneous or intravenous injection of 100 to 300 units (1 to 3 cc) of the U S P solution *of parathyroid—this helps maintain a normal serum calcium for* eight to eighteen hours, (c) dihydrotachysterol (A T 10) in doses of 2 cc two or three times each day by mouth—this is the most dependable agent to use for maintenance of normal concentration of calcium in the blood, (d) decrease blood *p*H by inhalation of 5 per cent carbon dioxide in oxygen or by rebreathing through a long tube *or into* a paper bag If sedation is needed, use 50 per cent magnesium sulfate in doses of 2 cc intramuscularly every six hours

2 Chronic tetany (a) High calcium—low phosphorus diet, (b) calcium salts—calcium chloride in 33 per cent solution in doses of 4 cc t i d (most effective, but least palatable) or calcium lactate or gluconate, 6 to 8 grams daily (c) calciferol or vitamin D_2 in daily doses of 100,000 to 400,000 units, (d) *if calciferol does not maintain normal calcium levels, dihydrotachysterol* in doses of 2 to 5 cc twice a week, (e) dilute hydrochloric acid in doses of 2 to 4 cc before meals, to promote calcium absorption and mild acidosis, (f) *desiccated thyroid (U S P) in doses of 0 13 to 0 25 gm daily to* mobilize calcium from bone and elevate the blood level

3 The dose of calcium ions for intravenous injection in the emergency treatment of hypocalcemia is 0 27 gram This is provided by any of the following

Calcium chloride 5 per cent	20 cc
Calcium gluconate 10 per cent	30 cc
Calcium lactate 5 per cent	40 cc

which require *not less than eight minutes* for injection time

4 Control of dosage by repeated determinations of serum calcium and serum phosphate is necessary since hypercalcemia is as harmful as hypocalcemia If facilities for blood chemical analyses are not available, determine calcium excretion in the urine, utilizing the Sulkowitch reagent which is a buffered oxalate solution of the following composition

Oxalic acid	2 5 gm
Ammonium Oxalate	2 5 gm
Acetic acid (glacial)	5 cc
Distilled water	150 cc

When equal volumes of urine and reagent are mixed, any calcium present in the urine appears as a fine precipitate of calcium oxalate

If there is no precipitate, the urine contains no calcium and the serum calcium level is probably 5 to 7 5 mg per 100 cc —a very low level A fine white cloud indicates a moderate amount of calcium and a normal serum calcium level A heavy milk white precipitate suggests hypercalcemia

Psychosis may be the sole manifestation of hypoparathyroidism, which also may be responsible, when untreated, for symmetrical cerebral calcification with mental deterioration Cataracts develop in almost all chronic cases

HYPERPARATHYROIDISM

(Generalized Osteitis Fibrosa Cystica)

This condition is seen clinically in two forms (1) Primary hyper parathyroidism caused by a hypersecreting adenoma of one parathy roid glandule, and rarely by diffuse hyperplasia of one or more glandules or carcinoma, (2) secondary hyperparathyroidism caused by chronic renal insufficiency (increased retention of phosphate) and associated with diffuse hyperplasia of all parathyroid glandules

Primary hyperparathyroidism is due to a single adenoma in 95 per cent of cases, occurring on the right or left side of the neck in one of the inferior parathyroids In about 10 per cent of cases the aden oma is located aberrantly in the thyroid, mediastinum, behind the esophagus or in the thymus Most adenomas are small, soft, encap sulated tumors, often too small to be palpable The average adenoma weighs 7 0 gm and has a grayish brown color, with a texture similar to that of normal spleen Rarely, it is malignant and metastasizes locally into the muscles and occasionally to the lungs and bones

Pathologic Physiology

The parathyroid adenoma produces excessive amounts of normal hormone The chief action of the hormone is to promote the renal excretion of phosphate and the second is to mobilize calcium from bone Decalcification of bone is therefore the first effect, especially if there has been a low calcium intake There is usually also cystic disease of bone, especially when the loss of calcium is rapid The in creased calcium loss leads to supersaturation of the urine and the calcium precipitates out as the phosphate in alkaline urine or as the oxalate in acid urine, so that calcium deposits may be formed any where in the urinary tract Precipitation in the renal tubular par enchyma may lead to impairment of renal function This may progress so rapidly as to cause death from uremia before much osteo porosis develops The condition may go unrecognized since chronic

severe renal failure may produce a high phosphate, which results in a low calcium blood level, tetany and a resulting stimulation of the parathyroids to hypertrophy Radiographic changes in bone are found in 90 per cent of cases and the urinary tract is involved in about 40 per cent The effects are confined to the urinary tract alone in about 5 per cent Calcification in soft tissues other than the kidney is occasionally seen

Clinical Picture

This condition may be seen at any age with a maximum incidence between thirty and sixty It is three times more frequent in females than in males and is characterized by an insidious onset and chronic progression Lassitude, asthenia and fatigue are early complaints resulting from the muscular hypotonia caused by the hypercalcemia Polyuria and polydipsia, weight loss, vomiting, anorexia and constipation then follow with increasing severity There is pain in the extremities and elsewhere Kyphosis, loss of weight and spontaneous fractures then occur Renal colic and the passage of renal calculi may be the first stimulus for seeking medical attention A crisis may occur during which flooding by the parathyroid hormone produces marked restlessness, tachycardia, prostration, uncontrollable vomiting and sudden death

There are three types of clinical manifestation of the disorder (a) Cystic degeneration of bone with an elevated blood calcium, a depressed blood phosphate and an elevated phosphatase (b) Generalized demineralization of bone without cystic degeneration The phosphatase is elevated only if there is osteoblastic activity The phosphate is always depressed and the blood calcium is elevated Types (a) and (b) may or may not have renal calculus (c) Nephrolithiasis, without significant bone changes, especially in young adults The blood calcium is not consistently elevated and the diagnosis requires repeated tests for blood calcium For this reason patients with recurrent renal calculus formation should have repeated determinations The value for blood calcium must be interpreted in terms of the total protein level (See chapter on Clinical Chemistry) The phosphatase may be normal If a renal calculus consists of pure or almost pure calcium phosphate, hyperparathyroidism should be suspected

The diagnosis is easy if the clinical picture is kept in mind and the following laboratory findings are obtained Serum calcium ranging between 11 and 16 and phosphate between 2 and 4 mg per 100 cc with a normal value for serum albumin and globulin, and nonprotein nitrogen Blood phosphatase is increased in most cases

Therapy

The only effective treatment is surgical removal of the adenoma In cases where diffuse hyperplasia of several parathyroids is found to be the cause of symptoms, subtotal resection should be done Since the adenoma may not be easily found, several exploratory operations, including mediastinotomy, may have to be performed

Preoperative preparation is of the greatest importance, since removal of the adenoma is followed by a precipitous fall in the serum calcium with imminent danger of severe tetany, especially if the phosphatase level is high Therefore, the patient must be given a high calcium diet, 6 to 8 grams of calcium lactate or gluconate and 100,000 to 200,000 units of Vitamin D_2 by mouth daily for a week prior to the day of operation and for about three weeks following operation The serum calcium must be measured within one to two hours after the operation If it is below normal, 10 cc of calcium chloride (10 per cent) or its equivalent in calcium must be given intravenously daily for the ensuing three days

Secondary hyperparathyroidism due to severe renal failure resembles the primary form, but the skeletal changes are less extensive Very rarely the renal injury from primary hyperparathyroidism may produce this superimposed secondary form In secondary hyperparathyroidism there is a long history of renal disease with hemorrhagic phenomena, hypertension, azotemia and a hyperphosphatemia and hypocalcemia, which is followed by parathyroid hyperplasia The blood phosphate level is always low in the primary form and always high in the secondary form It is the high phosphate which causes the low calcium and the latter in turn induces the secondary hyperplasia of the parathyroids

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Gonadotrophic Effects The anterior lobe secretes two hormones, which are essential to normal development and function of the gonads One of these, follicle stimulating hormone, stimulates the ovarian follicle in the female and Leydig cells in the male The other, luteinizing hormone, acts on the theca cells of the ovaries to produce the corpus luteum and on the seminiferous tubular cells of the testes to produce sperm These substances are present in the blood and urine during pregnancy, after gonadectomy, in all types of primary hypogonadism and in small amounts during the normal reproductive period The extracts obtained from pregnancy urine and the blood serum, particularly of mares, exert effects identical with those obtained from anterior pituitary gonadotrophins Thus, descent of the testes and considerable enlargement of these organs has been repeatedly observed following the use of pregnancy urine gonadotrophins and ovulation in the human female has been produced by the use of pregnant mare's serum

Thyrotropic Effects Hypophysectomy causes involution of the thyroid and adrenals as well as arrest in somatic growth and gonadal atrophy The frequent occurrence of toxic goiter in acromegaly and its less common development during the climacteric have suggested specific effects from the pituitary upon the thyroid Such thyrotropic effects of hypophyseal extracts have been shown to produce the typical histologic pattern associated with thyroid hyperactivity, as well as increased metabolic rate, tachycardia, weight loss and exophthalmos

Parathyrotropic Effects Pronounced parathyroid hypertrophy follows injection of pituitary extracts in rabbits and rats Parathyroid hyperplasia or adenoma occurs in acromegaly and pituitary basophilism The skeletal decalcification in pituitary basophilism, however, is not associated with hypercalcemia or hyperphosphatemia, but appears to be secondary to disturbances in protein metabolism produced by the hyperadrenocorticism, which is a fundamental feature of pituitary basophilism

Lactogenic Effects Lactation has been produced in nonpregnant female and male guinea pigs by the administration of anterior pituitary extracts, following the use of estrogens to produce breast tissue hypertrophy

Adrenotropic Effects Hyperplasia or adenomas of the adrenal cortex are commonly found in the syndromes of acromegaly and pituitary basophilism In experimental destruction or removal of the anterior pituitary and in Simmonds' disease adrenal cortical atrophy with signs of failure of adrenal function are characteristic

CHAPTER 32

THE PITUITARY

(See Chapter on Neurologic and Neurosurgical Disorders)

POSTERIOR LOBE

The *neurohypophysis* (posterior lobe) elaborates two hormones alpha hypophamine (pitocin), which contracts uterine musculature, and beta hypophamine (pitressin), which raises blood pressure and promotes the tubular reabsorption of water The latter "antidiuretic" effect is of the greatest importance in water metabolism

Diabetes insipidus is caused by deficiency of the antidiuretic hormone resulting from a destructive lesion involving the neuro hypophysis directly or indirectly The polyuria is the cause of the thirst Except for a specific gravity which rarely exceeds 1 005, the urine *is not abnormal Hysterical polydipsia is ruled out by the* erratic response to pitressin

The following special procedures are indicated measurement of water intake and output, stereograms of the skull for visualization of a lesion in or near the sella, fields of vision for detection of damage to the supra optic nuclei or optic chiasm Treatment medical (pitressin) unless there is an operable lesion

ANTERIOR LOBE

Physiology of the Anterior Hypophysis

A large number of hormonal effects are attributed to the anterior lobe, such as

Influence upon Growth There is no definite proof that a single substance or hormone is responsible for growth, which probably results from the combined effects of several hormones Growth hormone administration results in increased nitrogen retention, increased heat production due to an increased oxidation of fat and greatly increased water intake and output Gigantism results from an excessive supply of growth hormone before epiphyseal sealing takes place

rarely used alone when deterioration of vision is progressive or when there are definite field defects or pallor of the optic disks

Acidophil Adenomas

The endocrine abnormalities of these tumors usually become evident long before they become large enough to produce pressure effects, whereas the reverse is usually the case with chromophobe tumors Pronounced systemic acromegalic effects may occur before the sella is expanded Headache is a presenting complaint in 90 per cent of patients and visual impairment in about 50 per cent Roentgen therapy is more successful for acidophil than for chromophobe tumors Surgery must be resorted to, however, in all patients showing definite visual field defects Some will require postoperative x ray therapy for complete control of the endocrinopathy and the headache

Basophil Adenomas

These tumors usually are small and do not expand the sella turcica Irradiation of the pituitary region is the treatment of choice Several courses of treatment are required because of the varying radiosensitivity of these tumors As a rule, the percentage of improvement is inversely proportional to the duration of the disease

Procedures for Study The proper study of patients with pituitary tumor includes the following procedures

1 Stereograms of the skull to show sellar changes as well as other changes in the skull, jaw, sinuses and mastoid processes and changes *in* intracranial pressure, distortion of markings and calcification

2 X ray films of the spine and long bones to show osteoporosis, metastatic lesions, bone age, etc

3 Determination of visual fields and visual acuity as well as examination of the optic fundi to show pressure effects, if any These must be repeated frequently during treatment and during the intervals between treatments

4 Determination of the basal metabolic rate until a level is established, to show degrees of stimulation or failure of thyroid function In acromegaly uncomplicated by hyperthyroidism, the basal metabolic rate is about plus 20 per cent In mild hypopituitary states it is usually about minus 20 per cent, whereas in panhypopituitarism of severe degree (Simmonds' disease) it is usually minus 40 per cent

Thus the anatomical and functional integrity of the adrenal cortex depends upon an adequate supply of pituitary secretion

Diabetogenic Effects About 25 per cent of all acromegalic patients are diabetic Patients with hypopituitarism, as well as hypophysectomized animals, usually exhibit hypoglycemia and an increased carbohydrate tolerance Such patients and animals are insulin sensitive, while the acromegalic diabetic patient has a high degree of relative insulin resistance (Houssay in 1930 was the first to demonstrate that hypophysectomy alleviates the diabetes of pancreatectomized dogs Injections of anterior lobe extract had a contrainsular or diabetogenic effect in these animals)*

Lipoid-influencing Effects The adiposity previously attributed to hypophysectomy has been shown to result from lesions in neighboring structures such as the tuber cinereum and the hypothalamus Whole pituitary injections, however, seem to depress blood fat levels and to produce ketonuria Such pituitary extracts lessen the lipemic effect of ingested fat and appear to inhibit fat deposition

TUMORS

Clinical expression of overactivity of the pituitary is seen chiefly in three forms (a) either gigantism or acromegaly associated with hypersecretory tumors of the acidophil cells, (b) Cushing's syndrome, associated with the relatively rare basophil adenomas, (c) complete or partial pituitary failure due to chromophobe adenomas

Chromophobe Adenomas

These are much more common than the other types They frequently attain considerable size, enlarge the sella turcica and exert pressure upon the optic tract and the other pituitary cells Visual defects and increased intracranial pressure are the first manifestations Partial or complete pituitary failure follows This syndrome is also produced by craniopharyngeal pouch cysts, which are seen in children

Although most pituitary tumors are not immediately dangerous to life, the disabling symptoms and marked anatomical and physiological changes make treatment imperative

Treatment of the chromophobe adenomas requires surgical removal, irradiation of the pituitary region or a combination of the two Radiation is considered a valuable adjunct to surgery It is

* Houssay B A Biasotti A et al Endocrin *15* 511 1931

CHAPTER 33

PROSTATE, TESTES, THYMUS

THE PROSTATE

Cancer of the Prostate

This condition is the cause of death in some 5 per cent of men over fifty years of age It is usually not recognized until well advanced It arises as a rule in the posterior part of the gland and will show undifferentiated cells or, more commonly, adenocarcinoma It infiltrates the perineal lymphatics and metastasizes chiefly to regional lymph nodes and the bones of the pelvis The adenocarcinoma differs from the undifferentiated type in the fact that its cells produce large amounts of acid phosphatase Apparently this enzyme finds more ready access to the circulation from metastatic deposits than from the primary tumor, for an increase in the serum level of acid phosphatase is an index of the fact that metastasis has occurred The normal serum values are less than 4 5 units for acid phosphatase and less than 12 5 units for alkaline phosphatase When the former increases, the latter also rises An increase to 10 units or more of acid phosphatase is diagnostic of metastasis False negatives may occur in the case of osteolytic metastases, but false positives do not occur

Adenocarcinoma of the prostate thrives on the availability of androgens Treatment requires a modification of the hormonal status by orchiectomy and estrogen therapy Orchiectomy is followed by relief of pain, increased appetite, gain in weight and improvement in anemia The primary tumor shrinks and metastases disappear in a few months so that even the bones acquire a normal appearance in the x ray film Estrogen castration by the use of 5 mg daily of diethylstilbestrol is less efficient than orchiectomy because the inhibition of androgens by estrogens is not complete Estrogens, therefore, are used as a supplement to orchiectomy 2 mg daily of stilbestrol or in larger doses during a recrudescence of the disease or if the remission after orchiectomy is not complete Peripheral edema and gynecomastia during estrogen therapy require temporary omission or reduction of the dose Many patients are dramatically improved by the therapy described and a few "cures" of eight years' duration are on record

5 Determination of fasting blood sugar, dextrose tolerance and insulin tolerance to show degree of derangement in carbohydrate metabolism and, indirectly, the degree of adrenal cortical insufficiency or overactivity, as well as the functional state of the pancreas and liver

6 Measurement of serum proteins, sodium, chlorides and carbon dioxide to show degree of impairment of adrenal cortical function

7 Measurement of 17 ketosteroids and estrogen excretion to show degree of involvement of the gonads and the adrenal cortex

8 Measurement of the urinary or blood follicle stimulating hormone to show degree of damage to the anterior pituitary

9 Measurement of serum calcium, phosphate and phosphatase to show abnormality in mineral metabolism

Diagnosis True cryptorchidism must be distinguished from pseudocryptorchidism Migratory testes, namely those which move back and forth in the canal and occasionally from the abdominal cavity to the scrotum, are not true undescended testes and usually descend and remain in the scrotum after puberty In determining the presence or absence of true cryptorchidism, it is important that the testes be palpated on more than one occasion in the upright position, as the location of an undescended testis cannot be determined accurately with the patient in the recumbent position Embarrassment of the patient not infrequently causes retraction of the testis into locations where it cannot be readily palpated

Therapy Hormonal therapy consists of the use of chorionic or pregnancy urine gonadotrophins or methyl testosterone The former is administered subcutaneously in doses of 1 cc (500 to 1000 rat units per cc) three times a week for a period of two months At the end of this period, in about half the cases, there is usually evident significant growth of the genitalia and descent of the testis In order to avoid overstimulation of genital growth, it is advisable to wait two months before resuming treatment Some individuals show complete descent by the end of the rest period and hence do not require further therapy Most patients, however, need two or three courses of such treatment

Treatment by the oral administration of methyl testosterone—0 005 to 0 010 gram three times daily—should be resorted to only if three courses of chorionic gonadotrophins fail to bring about the desired result In a few such cases methyl testosterone will prove successful Methyl testosterone may produce a toxic hepatitis, with an early phase of obstructive jaundice It usually clears up if the drug is stopped Parenteral testosterone propionate may then be used

The optimum time to initiate therapy is considered to be in the two or three years before the onset of normal puberty, namely, when the boy is eight to ten years old Treatment at a slightly earlier age is probably advisable in cases with bilateral cryptorchidism

If no descent occurs after adequate trial of hormonal therapy, surgery must be resorted to because an abnormally located testis usually does not function and may develop malignant neoplastic changes In every such instance anatomic factors are found which prevented descent, such as fibrous bands, shortness of the structures to which the cord and testis are attached, abnormal direction of the peritoneal process or absence of the external ring Surgical intervention is necessary in about half the cases When it is not successful in

These therapeutic measures do not exclude total perineal prostatectomy for early cases of the disease, which can only be discovered by local evidence of "induration" of the lateral portion of the posterior wall on rectal examination and by biopsy (See chapter on Urologic Disorders)

THE TESTES

The testis consists of two parts (1) the seminiferous tubules which produce spermatozoa and (2) the interstitial cells (Leydig) which produce male sex hormone The development of secondary sexual characteristics, such as the growth of the penis, scrotum, prostate pubic and axillary hair, beard, change in the pitch of the voice and skeletal configuration depends upon the production of male sex hormone The integrity of the anterior lobe of the pituitary is essential for normal function of the testis, which, in turn, through its production of male sex hormone, serves as a check on the pituitary itself At puberty the anterior hypophysis produces the gonadotrophins, luteinizing hormone and follicle stimulating hormone, in sufficient amount to stimulate growth and function of both systems of the testis, the former stimulating the Leydig cells to produce male hormone and the latter stimulating the tubule cells to produce sperm Late puberty is considered not to require hormonal therapy unless it persists beyond the age of seventeen

Cryptorchidism

The testis normally moves into the scrotum during the last month of fetal life Descent is completed one or two months after birth In about one boy in 800 it fails to descend completely and is found in various abnormal locations Not all the factors involved in descent are known, but the conclusion seems warranted that failure of descent may be caused either by a deficiency of hormonal stimulation or by purely mechanical factors The location of the testis has an important bearing on the response to treatment Undescended testes are usually found in the inguinal canal, just inside the external ring or deflected from the external ring in various abnormal positions They are commonly deflected from the external oblique, occasionally toward the base of the penis and rarely into the perineum Such testes can usually be distinguished from those in the inguinal canal by the fact that they lie more superficially and can be moved readily under the skin Those in the upper part of the canal can sometimes be displaced into the abdomen

Hermaphroditism

The majority of patients with this condition have predominantly male characteristics Early recognition is desirable It is treated by removal of all female tissues, preservation of all male tissues and the postoperative administration of testosterone

THE THYMUS

Occasionally this gland is enlarged in association with myasthenia gravis Now and then removal of a thymic tumor, if present, will alleviate the severity of the myasthenia But the effect of operation is unpredictable and the relation between the tumor and the myasthenia is still obscure

bringing the testis to a sufficiently low level, it should be followed by one or two courses of chorionic gonadotrophin therapy

The view is held by some that if hormonal therapy causes descent, it is evidence that descent would have occurred eventually without it and there is therefore no need for hormonal therapy until it is required to supplement surgical repair * Nevertheless, if psychic trauma in the prepubertal child is due to undescended testis, the hormonal treatment is worth while (See chapter on Pediatric Surgery)

Impotence

This is almost always psychogenic A testicular origin might be suspected in patients with aspermia and increased urinary excretion of gonadotrophins Even after castration, the effect of the psyche is large and potency may be preserved if libido is preserved

Male Menopause

In 1 to 3 per cent of men over the age of sixty testicular failure may occur with resulting symptoms resembling those of the female menopause In noncastrates, the involutional atrophy can be detected by seminal fluid analysis, increased urinary secretion of gonadotrophins and rarely by testicular biopsy Treatment by 01 gm of methyl testosterone three to four times every day is adequate Long continued testosterone therapy in excess of 03 gm daily may induce prostatic cancer

Testicular Tumors

Teratoma testis occurs most frequently during the period of greatest sexual activity Its incidence is higher in cryptorchids and pseudohermaphrodites than in normal males The urine shows excessive gonadotrophins of two types—the chorionic, which is identical with that found in pregnancy urine, and follicle stimulating hormone similar to that found in castrates or menopausal urine Teratomas also excrete estrogens and even pregnandiol Whether the tumor is classified as embryonal carcinoma or otherwise, it is radioresistant and rapidly fatal The endocrine behavior of these tumors may be feminizing, producing gynecomastia, genital atrophy and impotence Chorionepitheliomas, aberrant adrenocortical tumors, benign paragangliomas and interstitial cell tumors may also produce these feminizing effects (See Malignant Testicle, p 235)

* Ladd W E and Gross R E Abdominal Surgery of Infancy and Childhood W B Saunders Co Philadelphia 1941

MALIGNANT DISEASE OF THYROID

1 Adenocarcinoma is of two types (a) Malignant adenoma, which shows blood vessel invasion If removed before metastases appear, cure usually results (b) Papillary adenocarcinoma—metastases usually to regional lymph nodes, lungs, bones—degree of malignancy mild

2 Squamous cell carcinoma is extremely rare, slow growing and fatal Surgery and x radiation are useless

3 Small round cell cancer is highly invasive It is considered lymphosarcoma by some The response to x rays is occasionally remarkable, but transitory

4 Giant cell cancer is highly malignant and strikingly pleomorphic It is very rare

5 Carcinoid is a rare papillary thyroid tumor, only locally malignant

Diagnosis

Clinical criteria of malignancy are as follows

There is a rapid increase in size Fixation is a late sign, dysphagia an early sign Dyspnea is out of proportion to the size of the tumor Cough and expectoration will occur in infiltrating tumors which ulcerate into the trachea or larynx Involvement of the recurrent laryngeal nerve is indicated by a change in voice, troublesome stridor or brassy cough Horner's syndrome appears if the cervical sympathetic is involved Pain from involvement of the cervical plexus is common The basal metabolic rate is usually normal

Differential Diagnosis

1 Riedel's disease requires biopsy for diagnosis

2 Lymphadenoid goiter is usually a diffuse goiter associated with early development of myxedema There is no fixation or pain A good response to a lymphoma dosage of x radiation is expected

3 Syphilis, tuberculosis and actinomycosis require specific blood tests or the discovery of the causative organism Therapeutic tests are usually helpful

Prognosis

The most favorable cases are those with papillary adenocarcinoma, next are the malignant adenomas and least favorable are those with diffusely growing carcinoma and lymphosarcoma

CHAPTER 34

THE THYROID

Acute thyroiditis or *strumitis* is usually seen as a complication of common infections, such as a virus, the pneumococcus, streptococcus, etc It is much more common in females than in males, especially the young The onset is usually acute with fever, leukocytosis, pain in *the distribution of the anterior cervical plexus, increased by swallowing* There is limited ability to elevate the chin The swelling appears early and is firm until suppuration sets in There may be dyspnea, paroxysmal cough, tachycardia The symptoms and signs reach a climax in seven to ten days and subside in another week, but there may be a relapse Hypothyroidism follows in 25 per cent of cases

Treatment is symptomatic Chemotherapy is also used If suppuration develops, there is an increase in pain and pressure symptoms, chills and fever, local redness and increase in leukocytosis Hypothyroidism is more likely to follow Incise and drain as soon as fluctuation appears

Iodine thyroiditis may follow prolonged administration of iodine compounds, especially in patients with nodular goiters Fever is absent The condition clears up within one week after omission of iodine medication

Differential diagnosis between *lymphadenoid goiter* and *Riedel's struma*

Lymphadenoid Goiter (Hashimoto)	*Riedel s Struma*
1 Preponderates in women from forty five to sixty	1 Occurs mostly in young men
2 Strong tendency to myxedema.	2 Myxedema only after radical operation
3 All parts of thyroid involved nothing outside Goiter firm not stony hard	3 Usually unilateral with extension to extrathyroid structures Goiter small very hard
4 Pressure effects seldom seen	4 Grave pressure effects the rule
5 Histologic structure characteristically extensive lymphocytic infiltration	5 The ma s is formed by dense scar tissue

Operation is avoided in lymphadenoid goiter except for biopsy X radiation is helpful Riedel's struma requires surgical extirpation

caused marked and rapid regression and is worth a trial If it fails, thyroidectomy must be resorted to, and if most of the gland is involved, the thyroidectomy usually amounts to total extirpation

Preparation for Thyroidectomy The following procedures are indicated (1) Vocal cord examination—to determine state of the vocal cords (2) Anteroposterior and oblique x ray films of upper thorax and neck—to determine the degree of compression and deviation of the trachea and also the possible extension of the goiter into the superior mediastinum (3) Basal metabolic rate (B M R) and blood cholesterol—to determine the state of thyroid function As a rule the B M R and blood cholesterol are within normal limits Rarely they indicate either mild hyperfunction (B M R = +10 to +15) or considerable hypothyroidism (B M R = −25 to −30 per cent and blood cholesterol 300 to 500 mg per 100 cc), in which case thyroidectomy must be preceded by the administration of saturated solution of potassium iodide, ten drops daily, for a period of seven to ten days or desiccated thyroid, 0 01 to 0 02 gram daily for two to three weeks

Intratracheal anesthesia is used because practically all patients requiring thyroidectomy show considerable compression and deviation of the trachea—conditions which seriously interfere with the airway during manipulation of the gland

Postoperative Care The patient must be observed for (1) Vocal cord paresis or paralysis resulting from compression or section of the recurrent laryngeal nerve (2) Hypoparathyroidism This is manifested within twenty four hours following thyroidectomy by paresthesias of the head, face and extremities and by muscle twitchings or contractures and a positive Chvostek or Trousseau sign (3) Development of hypothyroidism Since most, if not all, of the thyroid gland is removed, this sequel usually develops slowly, requiring two to three months to become complete

Nodular Goiter

Nodular goiter is an asymmetrical enlargement containing one or more discrete nodules of varying size and consistency It is usually the result of iodine deficiency, the nodules representing areas of hyperinvolution (colloid in varying stages of decay and cyst formation) Only about 10 per cent of nodular goiters are benign or malignant neoplasms These are not the result of iodine want A recent increase in size or the appearance of pain or dysphagia does not necessarily indicate malignancy More often such changes are due to hemorrhage into a benign cyst

Treatment

1 Surgery should be tried in all cases if at all operable

2 X ray therapy should be used in all cases where complete surgical extirpation is not possible and in those cases of radiosensitive tumors in which biopsy is the sole surgery indicated Radio iodine is useful in some malignant cases even for metastases

LATERAL ABERRANT THYROIDS

These are found in the neck lateral to the normal thyroid and occasionally well out toward the shoulder They may not be larger than a lymph node and are prone to develop malignant characteristics In fact, they may be regional metastases from a malignant nodule in the thyroid Most are papillomatous and sensitive to radiation The best treatment is surgical removal of the thyroid as well as the aberrant tissue and adjacent lymph nodes

GOITERS WITH NORMAL THYROID FUNCTION

Goiters associated with normal thyroid function appear clinically as diffuse or nodular goiters

Diffuse Goiter

Diffuse goiter, known also as diffuse nontoxic, simple, adolescent, iodine deficiency or colloid goiter, is a symmetrical generalized enlargement resulting from an extrinsic or intrinsic deficiency of iodine Since iodine is the raw material used in the synthesis of thyroid hormone, the thyroid gland is forced to work harder and longer to supply the normal demand for this hormone The goiter is the result of work hypertrophy and can be prevented or made to regress by supplying iodine In nonendemic regions, it occurs sporadically as a result of a relative or conditioned deficiency of iodine It becomes manifest when there is a natural increase in the demand for hormone, as in puberty and during pregnancy The gland is unable to meet this demand, either because of some inability to utilize the additional iodine or because of intestinal malabsorption The result is overwork hypertrophy and hyperplasia This goiter also may be prevented or reduced by making more iodine available Either iodine or desiccated thyroid in small doses usually causes marked regression of the goiter within six to eight months Occasionally very large goiters produce tracheal compression cough, dysphagia and dyspnea Neither desiccated thyroid nor iodine will cause sufficiently rapid reduction in size, but thyrotropic hormone in a few instances has

Diagnosis This can be made on sight in the typical case Occasionally not all the cardinal signs and symptoms are present Most of them may be mimicked by other conditions such as neurocirculatory asthenia, essential hypertension, leukemia or lymphoma, and the diagnosis may be difficult when a coincidental nontoxic goiter or temporary elevation of the basal metabolic rate exists in association with symptoms and signs which simulate some of those present in thyrotoxicosis Accordingly, each case must be carefully evaluated by the following diagnostic procedures

THE BASAL PULSE RATE This is best taken while patient is asleep or soon after waking In thyrotoxicosis its range is 90 to 100, whereas in conditions such as neurocirculatory asthenia the range is normal regardless of the rate when the patient is up and about

THE BASAL PULSE PRESSURE In thyrotoxicosis this is about twice normal, owing to elevation of the systolic pressure and lowering of the diastolic pressure It remains the same whether the patient is at rest or active In anxiety states it may be twice normal when the patient is active but it is usually normal under basal conditions

THE BASAL METABOLIC RATE This is evaluated by doing at least three determinations on consecutive or alternate days In thyrotoxicosis a level is readily established and the B M R remains at that level regardless of how many tests are done or how long the patient is kept in bed In all other conditions which may have hypermetabolism as one of the features, the B M R falls closer to the normal level with each succeeding determination

THE BLOOD CHOLESTEROL This is low in thyrotoxicosis A normal or high cholesterol excludes hyperthyroidism

A therapeutic test with iodides results in a quick reduction in the B M R in thyrotoxicosis, and most of the signs and symptoms almost wholly disappear within a few days All other conditions fail to respond so dramatically, no matter how closely they simulate thyrotoxicosis

Because the usual diagnostic measures do not reflect actual thyroid function, a positive diagnosis of hyperthyroidism may be difficult to make when hypertension, cardiac decompensation, leukemia and other disorders confuse the picture In such circumstances the protein bound blood iodine may be a better index than the B M R alone Thyrotropic hormone increases the concentration of this iodine complex while thiouracil and iodides decrease it

Treatment If the diagnosis is definite and there is no goiter, a chest x ray film may reveal a substernal goiter Most of the distressing symptoms can be permanently arrested or considerably allevi

Since most cases of nodular goiter show evidence of previous iodine deficiency, a trial of treatment with desiccated thyroid in a dose of 0 01 to 0 02 gram daily is indicated for a period of two to three months Such treatment results in complete regression of the nodule in about 10 per cent of cases If there is no regression, the treatment is surgical Surgery is indicated regardless of age, the size and consistency of the nodule or whether or not pressure symptoms are present, because there are no adequate clinical criteria for the diagnosis of early cancer of the thyroid and because at least 90 per cent of thyroid cancer originates in previously existing nodular goiter

Treatment is surgical—either unilateral or bilateral subtotal lobectomy Enucleation of the nodule alone results in a 20 per cent recurrence rate as compared with a 5 per cent recurrence rate when subtotal lobectomy is done

Postoperative Care If the nodule proves to be a malignant neoplasm, the question of postoperative radiation therapy should be decided on the basis of the type of malignancy found, i e , whether radiosensitive, rapidly growing or extending beyond the thyroid capsule These matters are discussed in more detail in the section dealing with thyroid malignancy

GOITERS WITH INCREASED THYROID FUNCTION

Hyperthyroidism may be associated with either a symmetrical diffuse thyroid enlargement or an asymmetrical nodular goiter Such goiters are usually referred to as toxic goiters

Diffuse Toxic Goiter

Diffuse toxic goiter Graves' syndrome, thyrotoxicosis or exophthalmic goiter, is considered to be a constitutional disorder of unknown etiology, characterized by spontaneous remissions and exacerbations eye changes, diffuse enlargement of the thyroid, tachycardia, tremors, increased appetite and loss of weight A few cases are clearly secondary to primary disease or hyperfunction of the anterior hypophysis, but most cases do not show any evidence of increased thyrotropic activity The relationship of other endocrine glands and the hypothalamus to this syndrome has been the subject of attractive but as yet fruitless speculation The only thing that seems certain is that the disease is not primary in the thyroid and that the thyroid is simply the organ responsible for the production of the most serious symptoms

quate salt and water to compensate for the loss from excessive sweat ing, hyperpnea and polyuria An adequate calcium intake is needed to prevent skeletal demineralization resulting from the characteristic increased excretion of calcium and phosphorus Supplements of vitamin B complex are also essential since the need for these vitamins increases with the level of basal metabolism Some patients show clinical evidence of vitamin B deficiency

4 IODIDE MEDICATION One cc of a saturated solution of potas sium iodide in milk, water or fruit juice once daily, or 1 cc of Lugol's solution t i d , or hydriodic acid syrup 4 cc t i d , should be adminis tered for a period of ten to fourteen days after the B M R level is established If at the end of this time the B M R is down to normal range and the patient's general clinical status is definitely improved, thyroidectomy may be done If not, defer thyroidectomy, continue with the iodides and add

5 PROPYLTHIOURACIL (Probacil) The dose is 0 05 gm q i d for two weeks, followed by 0 025 gm q i d for another two weeks or until there is clinical and laboratory evidence of a complete remission of the thyrotoxicosis This antithyroid drug works by blocking the enzyme systems concerned with the conversion of thyroglobulin into active hormone and does not interfere with the action of the iodide medication, which causes involution of the hyperplasia and reduces the increased vascularity of the thyroid parenchyma It usually takes four to six weeks to produce complete involution and to make thyroidectomy safe It is a toxic drug, capable of suddenly producing agranulocytosis, hepatitis, drug fever, cutaneous eruptions, edema and other disorders Therefore, the patient must be observed closely A leukocyte count must be done at least three times a week and if the total count falls to 4000 or less, the drug must be stopped An icterus index should be done at weekly intervals in order to detect early hepatitis

6 RADIOACTIVE IODINE This is becoming available for general clinical use The small number of cases so far treated has demon strated convincingly that the production of "internal radiation" can be easily accomplished with this isotope in doses not exceeding 10 millicuries in the average case and that satisfactory cures are pro duced in over 80 per cent of the patients treated It, therefore, holds a promise of eventually eliminating thyroidectomy as the therapy of choice for most cases of thyrotoxicosis

7 PREOPERATIVE PREPARATION This is the same as mentioned before for patients with nontoxic goiters, but must include the fol lowing special procedures (1) Judicious use of sedatives during the

ated by thyroidectomy in 70 to 80 per cent of cases The mortality should not exceed 1 per cent The rapidity of the relief obtained justifies the risk entailed of injury to the recurrent laryngeal nerve or to the parathyroids

Persistence of thyrotoxicosis or recurrence a few months after thyroidectomy occurs in 15 to 20 per cent of patients The gland does not necessarily show palpable regeneration These patients re main refractory for reasons unknown even after multiple operations The symptoms, however, are milder

The actual management of the disease is much more difficult than the simple prescription of thyroidectomy Adequate treatment must take the patient as a whole into consideration and embraces the fol lowing measures, which should be explained in the greatest detail to the patient in order to enlist maximum cooperation

1 PHYSICAL AND MENTAL REST These are essential since the average thyrotoxic patient when completely relaxed (B M R +50) expends as much energy as a normal individual would require while sweeping a floor Moreover, the cost of work is about 40 per cent greater because the hyperthyroid patient is inefficient in performance of work Rest must be intelligently prescribed Bed rest should not be enforced in patients who are too hyperkinetic Some form of oc cupational therapy is helpful So are (1) mild sedatives, (2) avoid ance of coffee, tobacco and alcohol, and (3) hydrotherapy Ambula tory patients should follow a daily schedule of rest periods

2 PSYCHOTHERAPY Thyrotoxic patients are irritable, excitable and restless, but they are usually surprisingly free from fears and other neurotic symptoms They are highly suggestible, however, and are influenced greatly by environment Uncertainty on the part of the physician or an attitude of gloom may be quite detrimental Cheerfulness, optimism and bright surroundings often have a strik ingly beneficial effect Simple talks with the patient, explaining the various manifestations of the disease and stressing the essential curability of the disorder win confidence and secure full cooperation

3 DIET For the average patient with moderate thyrotoxicosis the total calorie intake per day should range between 4000 and 5000 calories, even when completely at rest in bed, in order to compensate for the increased muscular activity and to insure gain in weight Since it is important to maintain optimum glycogen levels in the liver and the muscles, the carbohydrate and protein components of the diet must be high, at least 400 grams of the former and 1 5 gm / kg of body weight of the latter The rest of the diet can be made of fat, which is usually well tolerated The diet must also contain ade

Stridor or severe dyspnea or both indicate injury to both recurrent laryngeal nerves and require immediate tracheotomy These symptoms are obvious immediately after operation

If the signs of tetany appear, confirm it by a blood calcium determination If the symptoms are mild, give calcium lactate, 3 teaspoonfuls, q i d Twelve cc of cod liver oil or viosterol is given twice daily to facilitate calcium utilization If the symptoms are severe, give calcium intravenously and 10 to 50 units daily of parathyroid hormone To maintain a normal blood calcium 15 mg dehydrotachysterol (A T 10) is given daily by mouth until calcium appears in the urine Then decrease it to a level required to maintain a normal blood calcium, supplying a high calcium diet fortified with calcium salts Excessive A T 10 will produce the signs of hypercalcemia

If *hemorrhage* occurs, unusual fullness of the neck appears Tracheal obstruction with increasing dyspnea and dysphagia require immediate attention The skin flap must be elevated and the sutures coapting the prethyroid muscles in the midline severed so as to release pressure on the trachea This may have to be done before the patient is transferred to the operating room for definitive ligation of the bleeder The blood loss is not significant

A hematoma without respiratory obstruction is a venous ooze that requires evacuation with or without ligation of the vein responsible This is not an urgent measure, however

Thyroid crisis in properly prepared patients is rare It is most likely in toxic patients who have vomiting, diarrhea, delirium, extreme restlessness or hepatic damage indicated by jaundice These symptoms constitute a contraindication to surgery until corrected It is manifest within twelve hours postoperatively by a rapid pulse, high fever, uncontrollable restlessness and finally delirium Oxygen, cold packs, morphine and barbiturates in large dosage, a continuous intravenous 10 per cent dextrose drip containing 20 m of Lugol's solution per liter and transfusion of whole blood constitute the therapy, which frequently fails to prevent rapid death

day and evening before the morning of operation Most thyrotoxic patients tolerate phenobarbital or its sodium salt better than any other barbiturate This drug should be given in doses of 0 03 gm, three or four times during the day and 0 06 or 0 1 gm at bedtime On the morning of operation a dose of 0 015 gm of morphine sub cutaneously is given and repeated, as needed, every four to six hours (2) Give digitalis to all patients who have not ceased fibrillating, despite the control of the thyrotoxicosis and regardless of any present or past evidence of congestive failure This is best started three to four days before the day of operation and should be maintained by an adequate daily maintenance dose (0 1 to 0 2 gm) Thyrotoxic patients *do not* have special sensitivity to or intolerance for dig italis Quinidine is not indicated unless the patient continues to fibrillate for two or three weeks following thyroidectomy (3) Make sure the patient is well hydrated the day before thyroidectomy

Postoperative Care

The patient is placed in a semi sitting position with the head held forward by an extra pillow to relax the pretracheal muscles Oxygen by tent or Boothby mask may be used if there is cyanosis, but one must be sure in that case that there is no obstruction of the glottis The vocal cords should be looked at without delay and if they are both adducted an emergency tracheotomy is required Intravenous dextrose partly in water and partly in saline is given in large volume during the first two days because of the fever and sweating A dose of 20 drops of Lugol's solution is put in the first flask and is repeated once a day so long as there is continued toxicity Morphine is allowed liberally for restlessness Fluids and food by mouth are given as tolerated Visitors should be excluded for several days

If a drain was placed, it should be removed in twenty four hours and the wound inspected at that time for hematoma After two days alternate clips or sutures are removed Serum is evacuated as re quired by aspiration or by release with a probe and gentle pressure Activation is started on the third or fourth postoperative day Lu gol's solution (5 m) is given daily after the third day for a week and then decreased to 10 minims once a week for two months

Tracheitis may result from injury to the superior laryngeal nerve If troublesome it is treated by benzoin and steam vapor Use codeine and syrup of hydriodic acid for cough and hard candy or demulcents for the throat.

Stridor or severe *dyspnea* or both indicate injury to both recurrent laryngeal nerves and require immediate tracheotomy These symptoms are obvious immediately after operation

If the signs of tetany appear, confirm it by a blood calcium determination If the symptoms are mild, give calcium lactate, 3 teaspoonfuls, q i d Twelve cc of cod liver oil or viosterol is given twice daily to facilitate calcium utilization If the symptoms are severe, give calcium intravenously and 10 to 50 units daily of parathyroid hormone To maintain a normal blood calcium 15 mg dehydrotachysterol (A T 10) is given daily by mouth until calcium appears in the urine Then decrease it to a level required to maintain a normal blood calcium, supplying a high calcium diet fortified with calcium salts Excessive A T 10 will produce the signs of hypercalcemia

If *hemorrhage* occurs, unusual fullness of the neck appears Tracheal obstruction with increasing dyspnea and dysphagia require immediate attention The skin flap must be elevated and the sutures coapting the prethyroid muscles in the midline severed so as to release pressure on the trachea This may have to be done before the patient is transferred to the operating room for definitive ligation of the bleeder The blood loss is not significant

A hematoma without respiratory obstruction is a venous ooze that requires evacuation with or without ligation of the vein responsible This is not an urgent measure, however

Thyroid crisis in properly prepared patients is rare It is most likely in toxic patients who have vomiting, diarrhea, delirium, extreme restlessness or hepatic damage indicated by jaundice These symptoms constitute a contraindication to surgery until corrected It is manifest within twelve hours postoperatively by a rapid pulse, high fever, uncontrollable restlessness and finally delirium Oxygen, cold packs, morphine and barbiturates in large dosage, a continuous intravenous 10 per cent dextrose drip containing 20 m of Lugol's solution per liter and transfusion of whole blood constitute the therapy, which frequently fails to prevent rapid death

SECTION IV

Coincidental Medical Illnesses in Surgical Patients

CHAPTER 35

THE ANEMIAS AND BLOOD DYSCRASIAS

The globin fraction of hemoglobin is a protein which is synthesized in the body at the expense of other proteins, so that hemoglobin formation is not immediately reduced because of inadequate protein. However, a relationship between plasma proteins and red cell protein has been demonstrated in animals and undoubtedly a severe degree of protein malnutrition can affect globin formation and interfere with hemoglobin synthesis.

Other substances also are necessary for normal red cell production. One of these can be extracted from normal human and certain animal livers and is known as the anti-pernicious anemia principle. Brewer's yeast, dried hog's stomach, mammalian kidney and brain also seem to be sources of this anti-pernicious anemia principle. Related to these substances is the vitamin B complex, which has been shown to play a role in normal red cell development. Some of the factors in the B complex, especially vitamin B_{12}, have been found useful in the treatment of deficiency anemias. How these various materials are related is not as yet clear, but in the process of elucidation information of great value has been obtained. For example, a preparation originally isolated from spinach and a similar preparation synthesized from some organic acids have been found to stimulate the growth of *Lactobacillus casei* and to be capable of producing an effect in pernicious anemia similar to, but not identical with that of liver extract. It, therefore, appears that normal red cell development requires one or more substances present in normal liver and in other materials, the absence of which results in failure of normal development of the red cell, a pronounced increase in the megaloblasts of the bone marrow and changes in the tongue and nervous system resembling those seen in vitamin deficiency states.

Endocrine secretions apparently play a role in red cell formation. Thus, anemia may develop in myxedema and Simmonds' cachexia, and polycythemia is found in pituitary basophilism and in adrenocortical hyperfunction. The mechanisms involved are still obscure.

NORMAL VALUES FOR RED BLOOD CELLS

Red blood cell count	males	5 4 million ± 0 8
	females	4 8 million ± 0 6[1]
Hemoglobin	males	16 0 ± 2 0 gm /100 cc
	females	14 0 ± 2 0 gm /100 cc
Volume of packed red blood cell	males	47 0 ± 7 0 cc /100 cc
	females	42 0 ± 5 0 cc /100 cc
Mean cell diameter	7 5 ± 0 3 micra	
Mean cell volume	87 ± 5 cubic micra	

GENERAL SYMPTOMS OF ANEMIA

Regardless of the etiology, anemia is accompanied by certain general symptoms which are directly attributable to the low blood count and the consequent reduction in oxygen carrying capacity of the blood The general symptoms are pallor, weakness, dyspnea, palpitation, headache, tinnitus, vertigo, irritability and drowsiness or restlessness Anorexia, abdominal discomfort and constipation may occur Other symptoms may be present which are related to specific etiologic factors, such as central nervous system symptoms in pernicious anemia or leg ulcers in sickle cell anemia

CLASSIFICATION AND DESCRIPTION OF ANEMIAS

Iron Deficiency Anemias

Iron deficiency anemias are produced as the result of lack of iron, whether because of inadequate intake, poor absorption due to diarrhea achlorhydria or sepsis, continued blood loss producing a negative iron balance or excessive demand for iron

These anemias are characterized by a reduction in hemoglobin, which is proportionately greater than the reduction in red cells so that the red cells are poorly filled with hemoglobin and, in general, are smaller than normal The blood picture is otherwise not remarkable Reticulocytes are not increased, nor are nucleated red cells seen in the peripheral blood The bone marrow is hyperactive, but not megaloblastic

This type of anemia is of particular significance to surgeons because of the difficulties in supplying adequate nutrition to patients with surgical diseases This is especially true in gastro intestinal lesions which interfere with appetite and absorption, or, following operation, because of poor intake or defective absorption by virtue of the amount of stomach or intestine removed

The treatment for this group of anemias is primarily iron The simple injection of ferrous sulfate in some conditions will not suffice In surgical patients it is too slow so that whole blood transfusions are desirable if an immediate increase in the red cells is required

If time allows, iron therapy is usually given in tablets of ferrous sulfate or ferrous gluconate These may be obtained in 0 2, 0 25 or 0 3 gram size For adults three to six tablets daily are necessary They are best given after meals Addition of hydrochloric acid to the diet facilitates iron absorption in patients with hypochlorhydria or achlorhydria Gastro intestinal discomfort may occur from iron therapy Constipation or diarrhea are common In the event of gas tro intestinal symptoms, omission of the medication for a day or two, followed by gradually increasing doses, may result in the devel opment of tolerance to the iron salt Iron preparations differ in their effect on individuals A preparation which produces constipation in one person may not do so in another A patient who is unable to take ferrous sulfate may be able to take ferrous gluconate or other iron salts with vitamin B without difficulty

Parenteral iron (0 1 gm daily of 10 per cent iron and ammonium citrate solution intramuscularly) can be given, if indicated because of inadequate oral intake or absorption Parenteral iron may produce toxic symptoms If so, the initial dose should be 0 025 gm daily and increased gradually

Liver Deficiency Anemias

These include pernicious anemia, sprue, idiopathic steatorrhea, liver disease anemias, achrestic anemia, macrocytic anemia of preg nancy, occasional cases of carcinoma of the stomach and, occasion ally, macrocytic anemia following gastrectomy All these anemias are produced as the result of a deficiency of some factor which is es sential for red cell maturation This factor can be alluded to as the anti anemic principle of liver, since liver extract is effective in the treatment of most of these conditions

In the absence of this liver factor, maturation of most of the cells stops at the megaloblast level and the bone marrow becomes hyper active with a marked increase in megaloblasts Because the need for the few cells which do mature is great, they, together with nucleated red cells, enter the peripheral blood earlier than is normally the case Since the reticulocyte and the early mature red cell are larger than the average mature red cell, there is a pronounced macrocytosis in these anemias There is leukopenia and the granulocytes are multi lobular

Other symptoms and signs depend on the special etiologic factor in each type of anemia For example, in pernicious anemia achlor hydria, smooth tongue and degenerative changes in the posterior and lateral columns of the spinal cord are characteristic *In sprue*

and idiopathic steatorrhea, free hydrochloric acid usually is present, but there is severe diarrhea In liver disease, such as cirrhosis, the anemia may be only one of many findings or the only finding

Liver deficiency anemias can be caused by a variety of factors, as explained by Castle's hypothesis, which states that for normal red cell development an extrinsic factor obtained from certain foods (beef, eggs, milk, yeast) is acted upon by an intrinsic factor in the human stomach, the product is absorbed from the intestinal tract, stored in the liver and furnished to the bone marrow as needed At any point this process may be interfered with and anemia develops Thus, nutritional macrocytic anemia may develop from lack of the extrinsic factor, carcinoma of the stomach or gastrectomy may remove the intrinsic factor Pernicious anemia is probably due to an absence of the intrinsic factor In sprue and steatorrhea absorption is defective and in liver disease storage is interfered with

Treatment of these disorders is carried out with intramuscular liver extract Given in adequate quantities this produces a change from a megaloblastic to normal bone marrow, a pronounced reticulocytosis, which reaches a peak about seven to ten days after beginning treatment and a gradual return of the red count and hemoglobin to normal levels Liver extract in doses of 10 to 15 units intramuscularly should be given daily until the reticulocyte rise appears It is then given two or three times weekly and then only as the patient's needs require Liver preparations may be given orally, but response is much slower and in the long run more expensive The liver extracts now on the market have been greatly refined and usually contain little else than the anti anemia principle It has been claimed by some that crude liver extract is more desirable than the refined

Because of the protein content of liver extract, hypersensitivity to liver extract may develop Usually this development can be met by changing to liver extract prepared from a different species of animal, e g , from hog to beef liver Sometimes it is necessary to desensitize the patient to liver extract in the same way that individuals sensitive to horse serum are desensitized

Some macrocytic anemias, for reasons that are not clear, do not respond well to liver extract even in large doses Anemia of hepatic cirrhosis and achrestic anemia are two examples In cirrhosis a slight reticulocyte rise and some improvement in the blood picture may occur, but achrestic anemia does not respond at all

A group of closely related substances isolated from the vitamin B complex, known as "folic acid," was originally found to influence the growth of bacteria and subsequently to produce an excellent

reticulocyte response in pernicious anemia, nutritional macrocytic anemia, sprue and several other varieties of macrocytic anemia The active component is pteroyl glutamic acid, which is effective in a dose of 15 to 30 mg daily, but it does not cure the neurologic disorder

Crystalline vitamin B_1, in a dose of 25 micrograms twice weekly, cures both the anemia and the neurologic disorder

Anemias Due to Bone Marrow Depression

This group of anemias can be subdivided into three general classes

(a) Chemical depression—examples are benzol or arsenic poisoning and sulfanilamide intoxication

(b) Toxic depression—following severe infections, nephritis, endocrine disorders, x radiation

(c) Mechanical depression—replacement of marrow by fibrous tissue or by leukemic or other malignant cells

These disorders do not respond to the usual treatment of anemias They do not resemble the liver or iron deficiency disorders and may progress in spite of treatment with liver or iron The blood shows red cells of normal size and hemoglobin content The bone marrow is either hypoactive or is replaced by non blood forming tissue

The treatment is directed at removal of the primary cause Transfusions help to sustain the patient until the marrow can produce red cells

Anemia due to Acute Blood Loss

Anemia due to acute blood loss shows a reduction in the number of red cells, but no significant change in their appearance A leukocytosis occurs If it persists, continued bleeding should be suspected If blood loss ceases, the bone marrow promptly becomes hyperactive and a transient reticulocytosis occurs If iron stores are low, it may be necessary to add iron to the diet to compensate for the iron lost by the hemorrhage

Although an otherwise healthy person will replace his blood loss in time, blood transfusion greatly improves the feeling of well being restores strength and appetite and speeds recovery

Hemolytic Anemias

These can be divided into two groups

(1) *Congenital*—which includes congenital hemolytic icterus, sickle cell anemia and Mediterranean anemia

and idiopathic steatorrhea, free hydrochloric acid usually is present, but there is severe diarrhea In liver disease, such as cirrhosis, the anemia may be only one of many findings or the only finding

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A group of closely related substances isolated from the vitamin B complex, known as "folic acid," was originally found to influence the growth of bacteria and subsequently to produce an excellent

hemolysis ceases Transfusions must be done with unusual care because of the possibility of increasing hemolysis as a result of agglutinins or hemolysins, which may be present in either the donor or recipient It is the patient's own red cells which are usually hemolyzed

Polycythemia vera (primary polycythemia, Vaquez Osler disease or erythremia) predominates in Jewish males It generally appears in middle age and produces headaches, dizziness, tinnitus and visual disturbances The face and chest are usually plethoric and the spleen is generally enlarged Because of a tendency both to hemorrhage and thrombosis, various symptoms, such as hemiplegia, gastro intestinal pain or hemorrhage, genito urinary bleeding, may occur The red count may go as high as 10,000,000 and hemoglobin to 20 to 24 grams Both blood volume and plasma volume are increased, but not in proportion to the increase in red count, so that viscosity may be five to eight times normal The red cells usually appear normal There is a leukocytosis, which at times reaches levels of thirty to forty thousand Occasional cases convert to myelogenous leukemia after several years Platelets are increased Bone marrow is hyperactive Vascular disease of the extremities (intermittent claudication) in later life and skin ulcerations and infections are fairly common Hemorrhage, spontaneous or from the site of a tooth extraction or peptic ulcer, is a common complication, as is also cirrhosis of the liver A low prothrombin time may be found It may be necessary, therefore, to administer vitamin K if there is hemorrhage

Treatment is by one of several methods Chemicals such as arsenic or phenylhydrazene have been used, but are less popular now Radiation therapy either by x rays or radioactive phosphorus has been used with good results Venesection until normal counts are reached is one of the best forms of treatment These methods of treatment apply only to polycythemia vera

In *secondary polycythemia* venesection may increase discomfort The red cells increase secondary to anoxemic states heart or lung disease, reduced oxygen tension at high altitudes Few, if any, symptoms can be attributed directly to the secondary polycythemia, which is a compensatory mechanism that disappears if the cause of the anoxemia can be eliminated

DISORDERS OF THE BLOOD CLOTTING MECHANISM

A two step process is generally accepted as the *normal clotting mechanism* There is still disagreement regarding the exact

(2) *Acquired*—of which there are four varieties

(a) Immunologic—due to formation of isohemolysins

(b) Chemical—due to action of drugs such as phenyl hydrazene and sulfonamides

(c) Infectious—malaria, bartonella infection

(d) Symptomatic—in association with various diseases such as Hodgkin's disease, carcinomatosis, liver disease, etc

Because the destruction of red cells occurs in all types of hemolytic anemia, certain features are common to all of them In addition to the general symptoms of anemia there is jaundice, proportional to the amount of red cell destruction While there is no bile in the urine, urobilinogen in the urine is markedly increased Hemoglobin frequently appears in the urine The increased red cell destruction renders the bone marrow hyperactive so that reticulocytes and nucleated red cells appear in the peripheral blood The recticulocytes may constitute up to 30 to 40 per cent of the circulating red cells The red cells may vary in size from very small dense spherocytes to large ones appearing as a result of the bone marrow stimulation Spherocytosis is characteristic of congenital hemolytic icterus, but it may be seen in other forms of hemolytic anemia White cells and platelets are increased The increased fragility of the red cells to hypotonic saline has been related to the spherocytosis The spherocytes in some hemolytic anemias are said to carry an adsorbed serum globulin which makes them more vulnerable to destruction by the splenic pulp Of equal interest is the increased resistance of red cells to hypotonic saline in other forms of congenital anemia

Sickle cell anemia, found only in Negroes, is a hemolytic anemia in which the red cells elongate and become crescentic, especially in a high carbon dioxide environment Attacks of abdominal pain, vomiting, leg ulcers neurologic manifestations, such as blindness or convulsions and bone changes, all said to result from multiple thromboses, characterize the disease

Congenital hemolytic icterus is a familial disease with repeated attacks of hemolysis usually beginning in childhood There is a predisposition to gallstones The spleen is enlarged and the bones show a characteristic x ray pattern

Treatment of congenital hemolytic icterus is splenectomy This procedure may also occasionally be effective in certain other hemolytic anemias, such as immunological anemias and the symptomatic groups *If splenectomy is not indicated or ineffective, treatment consists* in removing causative factors and in giving transfusions until

Bleeding Time This test does not reflect a disturbance in the clotting process, but is a measure of the contractility of the small capillaries following injury Duke's method is most commonly used Normal time is one to three minutes

Clot Retraction Time The process of clot retraction depends primarily on the presence of a normal number of platelets It is prolonged when the platelets are reduced to 70,000 or less per cu mm and in pronounced prothrombin deficiency Normal clot retraction occurs in thirty to sixty minutes

Prothrombin Time This test indirectly measures the plasma prothrombin, which at present is not susceptible to direct measurement If the thromboplastin and calcium content of plasma are made constant and optimum, the coagulation time is the measure of the plasma prothrombin Conditions are so adjusted that the clotting time of normal plasma varies from twelve to fifteen seconds The results can be given in terms of the time required for the test plasma to clot as compared with normal plasma, or the percentage of prothrombin calculated from Quick's formula When the prothrombin time is over thirty five seconds, spontaneous bleeding may occur Below this level a bleeding tendency may exist, and may be made manifest by other minor derangements of the hemostatic mechanism

Capillary Fragility Test This crude test measures the resistance of the capillaries to rupture Various methods are used, the commonest (Rumpel Leede) is the use of a blood pressure cuff on the arm, inflated to a level between systolic and diastolic pressure for five minutes, following which the petechiae in a circumscribed area below the cuff are counted

Platelet Count Blood with a low platelet count may coagulate normally, and individuals with a normal platelet count may show a bleeding tendency In general, the bleeding tendency of thrombocytopenic purpura is proportional to the decrease in platelets Several methods are available, all require considerable technical experience if consistent results are to be obtained The normal platelet count is between 250 000 and 500,000

HEMORRHAGIC DISEASES

Bleeding of Unknown Origin

Bleeding of unknown origin requires the following diagnostic tests platelet count bleeding and clotting time and the Rumpel Leede test

nature of the reactions involved, but the fundamental steps are as follows

Prothrombin + Calcium + Thromboplastin = thrombin*
Thrombin + fibrinogen = fibrin (the clot)

The chief controversial point is whether thromboplastin in the first step acts as an enzyme or takes direct part in the chemical reaction The weight of evidence favors the latter The second step is an enzymatic one, with thrombin being released into the serum after fibrin has been formed

Prothrombin and fibrinogen, as derived from the liver, are normal constituents of the plasma globulins Recent work suggests that ad ditional plasma fractions exist, which play a role in the clotting mechanism † Thromboplastin is probably released from platelets and tissue juices at the site of vessel injury

Types of Abnormalities of the Clotting Mechanism

Acceleration of coagulation Increased platelets, prothrombin or its activators accelerate clotting Increased viscosity of blood, slow ing of rate of blood flow or endothelial injury favor intravascular clotting

Snake venoms, tissue extracts, trypsin or thrombin accelerate blood clotting and have some use as hemostatics

Delayed or defective coagulation Factors which reduce the pro thrombin, calcium, thromboplastin or fibrinogen interfere with the normal clotting mechanism Heparin delays coagulation, but its part in the normal clotting mechanism is not known When added to blood, heparin counteracts thromboplastin and intensifies anti thrombic factors present in normal plasma Dicumarol probably acts by blocking the synthesis of prothrombin in the liver

Tests for Abnormalities of the Clotting Mechanism

(For technic see chapter on Clinical Pathology)

Coagulation Time This test does not measure any single com ponent in the clotting process Normal clotting time by the capillary tube method is two to four minutes and by the Lee White test tube method five to eight minutes, but ranges of three to seven and six to fifteen minutes respectively, have been observed

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* Recent work indicates that this reaction also releases prothrombin activators which autocatalyze the reaction (Owren P A Acta med Scandinav Supplement 194 1947) Alexander B et al Blood Jour Hemat In press

† Quick A J Am J Physiol *151* 63 1947

The prothrombin time is prolonged The coagulation time may or may not be increased Bleeding from the intestinal tract, the cord or into organs is common The symptoms usually start on the second, third or fourth day after birth and depend on the location of the bleeding Treatment is either whole blood transfusion or vitamin K or both Some form of vitamin K is usually given to all infants at birth as a prophylactic measure Two mg of menadione intramuscularly is generally sufficient to prevent or stop bleeding

Liver disease of sufficient degree to interfere with the synthesis of prothrombin may result in bleeding There must be a great reduction in prothrombin before bleeding occurs Since bile salts are essential for the normal absorption of vitamin K from the intestinal tract, obstructive jaundice results in a reduced formation of prothrombin Spontaneous bleeding in this condition or in primary liver disease with reduced prothrombin formation is rare, but bleeding may occur following surgery and then presents a serious complication With vitamin K now available, this type of postoperative complication is rare Total biliary fistula continuing over a long period of time will ultimately result in a reduced formation of prothrombin Care must be taken to provide bile salts and vitamin K to such patients

Vitamin K deficiency may occur in any disease of the intestinal tract which results in inadequate absorption Diarrhea from any cause, fistulas or prolonged use of chemotherapeutic agents for intestinal antisepsis may also produce the deficiency The treatment is intramuscular vitamin K

Prothrombin deficiency is frequently produced in modern surgery by the use of dicumarol as an anticoagulant This produces a drop in the prothrombin content of the blood Its continuation or excessive administration may result in severe hemorrhage This effect is particularly insidious because it takes some time to develop and persists for several days after the dicumarol has been stopped Several transfusions may be necessary Vitamin K_1 oxide intravenously may be helpful

Hemophilia

The single characteristic feature of hemophilia is a prolonged clotting time Two theories have been proposed to explain this disease One places the defect in the platelets, which, though normal in number, are said to be highly resistant to breakdown thus failing to release thromboplastin, with a resulting prolonged coagulation time The other theory, based on more recent and more conclusive evi

Thrombocytopenic Purpura

(See Chapter on The Spleen)

Thrombocytopenic purpura may be primary or secondary to bone marrow depression by drugs, leukemia and neoplastic disease or to platelet depression by drugs, e g , sedormid

The platelets are reduced, frequently to levels below 50,000 The anemia is in proportion to the amount of blood loss which has occurred The other laboratory data of significance are a prolonged bleeding time, poor clot retraction and a positive (increased) capillary fragility test

The bleeding tendency is related both to the platelet reduction and to increased capillary fragility, which in turn is said to be due to release of histamine The role of the spleen is obscure, a splenic factor which depresses platelets has been described, but its importance is not established

The treatment for the primary type is splenectomy, preceded by adequate transfusion The operation should be done during a quiescent period rather than during an acute crisis, when the mortality rate is higher Usually there is marked increase in platelets immediately after operation, but the platelet count may later drop to a very low level without recurrence of bleeding Splenectomy for the secondary type is not satisfactory Transfusions provide the best therapy and removal of the offending agent, if possible, should be done

Nonthrombocytopenic Purpura

Some types of purpura do not show a reduction in platelets In this group of disorders the clotting mechanism often is not at fault This type of purpura occurs in allergic disorders, vitamin C deficiency, in which a defective connective tissue results in increased capillary fragility infections—meningococcic sepsis, subacute bacterial endocarditis, smallpox, diphtheria, scarlet fever etc Hemorrhage in infections is due to either septic emboli or toxins which damage capillaries

Bleeding from Prothrombin Deficiency

Prothrombin deficiency as a cause of bleeding occurs under strictly limited conditions, viz hemorrhagic disease of the newborn, advanced liver disease vitamin K deficiency from any cause

Hemorrhagic disease of the newborn is the result of inability of the liver to form prothrombin in the very early days of life or of an inability of the mother to make vitamin K available to the fetus

likely diagnosis Even bone marrow study does not always make a clear differentiation possible The differentiation is purely academic, however, since all types of acute leukemia terminate fatally in spite of treatment Recently "aminoptyrin," a modification of pteroyl glutamic acid, has been tried with some promise of benefit

Chronic Leukemia

Chronic leukemia has an insidious onset The diagnosis is fre quently make accidentally, e g , by finding a marked leukocytosis in the course of a routine white cell count done preoperatively, or by finding a large spleen in the course of a routine physical examination Because of the prolonged course of the disease and the wide variety of organs which may be involved, almost any conceivable clinical picture is possible The clinical course, even without treatment, may extend over a period of many years The patient may appear in good health or severely cachectic, depending on the state of the disease Lymph node enlargement is uniformly present in lymphatic leuke mia at an early stage, whereas it usually appears relatively late in myelogenous leukemia The lymph nodes are usually discrete and rubbery, with much variation in size Splenomegaly is present in both types It may be painless or there may be pain, either from pres sure or from infarcts of the spleen The liver is usually enlarged The more common sites of secondary involvement are skin, bones, nerv- ous and genito urinary systems

There is practically always a great increase in the total white cell count, with counts as high as 400,000 in myelogenous leukemia The peripheral blood smear gives the diagnosis Myelocytes, myeloblasts or lymphoblasts may be identified in the smear

Hodgkin's disease and lymphosarcoma are seldom treated effec tively by surgery In the occasional case a solitary lesion, if com pletely excised, seems to postpone recurrence indefinitely Nitrogen mustard therapy and radiation therapy are used together as pal liatives

Leukopenia

Leukopenia is a subsidiary phenomenon of no special significance in disorders such as Banti's syndrome, aleukemic leukemia and aplastic anemia, but it is the central disorder in agranulocytosis, in which the clinical picture is closely related to the sharp decline in the polymorphonuclear cell count

dence, places the defect in the plasma globulins, some fraction of which, present in normal plasma, is missing *

Treatment of the disease is by transfusion of fresh plasma or whole blood Fractions of plasma, isolated from whole plasma, or placental extracts have also been used with some success, but thus far the effective fraction has not been isolated with any degree of purity The most effective method of preparing a hemophilic patient for surgery or of controlling spontaneous bleeding is by giving 100 cc of fresh plasma intravenously every twenty four hours † Fibrin foam and gelatin foam, with or without thrombin, are useful for application to bleeding areas

DISEASES OF THE LEUKOCYTIC SYSTEM

Acute Leukemia

Acute leukemia is characterized by sudden onset and runs a relatively short fatal course, usually lasting about two months There is marked prostration, weakness and a rapidly developing anemia, fever and general malaise, often simulating the picture of severe sepsis Bleeding or ulceration of mucus membranes, sore throat and severe gingivitis may be present Purpuric manifestations in the skin and mucus membranes are common Lymph nodes may be enlarged to great size or remain insignificant Splenomegaly is practically always present The liver is often enlarged Other signs of the disease depend on localization, priapism or hematuria indicate genito urinary involvement Pleural effusion is seen occasionally Cerebral nervous system involvement is not infrequent Joint pains are common in children

The anemia develops rapidly and is normocytic in type Nucleated red blood cells may be seen in the smear Platelets are reduced, clot retraction is poor and bleeding time is usually prolonged

The white blood cell count may be misleading, because it is not uncommon for the total count to be normal or low At times there may be a pronounced leukopenia In the majority of cases, however, there is a leukocytosis, which may range from values just above normal to counts higher than 100,000 per cu mm The identification of the type of leukemia by the white blood cells is frequently difficult Their most outstanding features are their immaturity and bizarre forms Where there is a high proportion of recognizable polymorphonuclear leukocytes, myelogenous leukemia is the most

* Patek A J and Taylor F H L J Clin Invest *16* 113 1937

† Alexander B and Landwehr G J A M A *138* 174 1948

likely diagnosis Even bone marrow study does not always make a clear differentiation possible The differentiation is purely academic, however, since all types of acute leukemia terminate fatally in spite of treatment Recently "aminoptyrin," a modification of pteroyl glutamic acid, has been tried with some promise of benefit

Chronic Leukemia

Chronic leukemia has an insidious onset The diagnosis is frequently make accidentally, e g , by finding a marked leukocytosis in the course of a routine white cell count done preoperatively, or by finding a large spleen in the course of a routine physical examination Because of the prolonged course of the disease and the wide variety of organs which may be involved, almost any conceivable clinical picture is possible The clinical course, even without treatment, may extend over a period of many years The patient may appear in good health or severely cachectic, depending on the state of the disease Lymph node enlargement is uniformly present in lymphatic leukemia at an early stage, whereas it usually appears relatively late in myelogenous leukemia The lymph nodes are usually discrete and rubbery, with much variation in size Splenomegaly is present in both types It may be painless or there may be pain, either from pressure or from infarcts of the spleen The liver is usually enlarged The more common sites of secondary involvement are skin, bones, nervous and genito urinary systems

There is practically always a great increase in the total white cell count, with counts as high as 400,000 in myelogenous leukemia The peripheral blood smear gives the diagnosis Myelocytes, myeloblasts or lymphoblasts may be identified in the smear

Hodgkin's disease and lymphosarcoma are seldom treated effectively by surgery In the occasional case a solitary lesion, if completely excised, seems to postpone recurrence indefinitely Nitrogen mustard therapy and radiation therapy are used together as palliatives

Leukopenia

Leukopenia is a subsidiary phenomenon of no special significance in disorders such as Banti's syndrome, aleukemic leukemia and aplastic anemia but it is the central disorder in agranulocytosis, in which the clinical picture is closely related to the sharp decline in the polymorphonuclear cell count

Agranulocytosis

Agranulocytosis is usually the result of sensitization of the granulocytes to a drug, especially to amidopyrine, the sulfonamides, thiouracil, and coal tar products such as pluracetin The clinical picture is characterized by high fever, chills, severe sore throat, dirty gray ulcerations of mucous membranes, severe prostration, vomiting and mental confusion The course is often short and rapidly fatal because of a sudden, overwhelming infection, permitted by the disappearance of the normal leukocytic defense The total white count is usually below 2000 per cu mm , and may go as low as 200 per cu mm Polymorphonuclear cells are absent or almost entirely absent Red cells are not affected

Treatment consists in keeping the patient alive by whatever means are available until the effect of the sensitizing agent has worn off and the bone marrow can put out white cells again The offending agent must be removed at once and the infection treated by massive sulfonamide or penicillin therapy, which may be effective within several days to a few weeks The value of preparations designed to stimulate white cell formation, such as pentonucleotides, adenine sulfate, folic acid or bone marrow, is questionable, but they are usually employed

Infectious Mononucleosis

Infectious mononucleosis is an acute infection, usually benign, characterized by varying degrees of fever, sore throat, enlargement of the lymph nodes, particularly those of the neck, and a typical change in the appearance of the white cells of the peripheral blood The etiology is not known, both virus and bacterial causes have been postulated The incubation period is approximately ten days The condition is generally ushered in by vague constitutional signs There is no typical fever curve Sore throat, which may vary from a mild irritation to a violent membranous pharyngitis resembling diphtheria is almost always present The lymph nodes of the neck usually become enlarged early in the disease, but they may not appear until several weeks after the onset The nodes are usually discrete, firm and only slightly tender Enlargement of axillary and groin lymph nodes occurs, but less frequently than enlargement of the cervical nodes The spleen is frequently enlarged, the liver less often Jaundice occasionally occurs due to a hepatitis or obstruction to biliary drainage by lymph node enlargement Other sites (the heart, kidneys, skin, peritoneal lymph nodes and nervous system) may be involved The disease lasts from two to four weeks, but may

go on longer The chief point of surgical interest is occasional spontaneous rupture of the spleen or symptoms suggesting peritonitis

The blood shows an increase in the total white count to levels between 15,000 and 20,000 Not only are lymphocytes and monocytes increased, but a cell type appears which is not normally seen This cell is larger than the mature lymphocyte, but smaller than the normal large lymphocyte The nucleus is usually indented The cell probably represents an abnormal lymphocyte There may be as many as 95 per cent mononuclear cells in the smear at the height of the disease, the peak of the disease usually corresponds to the peak of the mononuclear count As defervescence occurs, the differential count returns to normal

One laboratory finding of great significance in the diagnosis of infectious mononucleosis is the appearance of heterophile antibodies in almost all cases These antibodies appear after the first week and may remain in the blood for several months Generally a titer of 1 32 or 1 56, depending on how the dilutions are made, is taken to be the lower limit of a positive test, a steadily increasing titer is much better evidence

The disease rarely ends fatally When this happens it is generally the result of some unforeseen complication, such as ruptured spleen or central nervous system involvement affecting the respiratory center There is no specific therapy for this disease

CHAPTER 36

CARDIAC DISEASE

Heart disease may simulate surgical conditions For example, the clinical picture in active rheumatic fever may resemble appendicitis or peritonitis Acute pericarditis may resemble esophageal or upper abdominal disease Congestive heart failure may resemble acute cholecystitis, intestinal obstruction or liver disease Acute myo cardial infarction may resemble perforated ulcer, acute pancreatitis or cholecystitis

Heart disease may produce surgical complications—suppurative pericarditis, embolus to great vessels, cardiac tamponade It is fre quently complicated by thrombophlebitis of the lower extremities and pulmonary embolism

Elective surgery is contraindicated in active rheumatic fever, impending or acute myocardial infarction, congestive heart failure, especially when acute or severe, and a high grade auriculoventric ular block with Adams Stokes syndrome *Elective surgery may be done with a greater than normal risk* in chronic angina pectoris, after convalescence from myocardial infarction, aortic stenosis and in luetic heart disease *Elective surgery may be done with no more than the usual risk* in asymptomatic mitral valvular disease, asymptomatic hypertensive heart disease, asymptomatic congenital heart disease, hyperthyroid heart disease after control of thyrotoxicosis, auricular fibrillation or flutter after adequate control of the ventricular rate with digitalis, and in first degree auriculoven tricular block

Surgery may be performed in any cardiac case if it is a life saving measure

Preparation of Cardiac Patients for Surgery The heart condition must be properly assessed so as better to prepare the patient for surgery and to deal with postoperative complications Ascertain if the patient is taking digitalis To obtain an optimum general con dition

(1) Restore compensation by digitalization, a low salt diet and diuretics if necessary

(2) Control ventricular rate by digitalization in auricular fibrillation or flutter

(3) Correct dehydration and anemia and restore electrolyte balance For this purpose one must establish as good renal function as possible and control diabetes, if present

Syncope and convulsions resulting from pressure on the *carotid sinus* may require denervation of the sinus The sensitivity is increased by digitalis An attack may be precipitated by pressure during neck operations If this syndrome is present, atropine, 1 mg, subcutaneously or directly into a hypersensitive sinus, may prevent cardiac standstill

Reassure the patient concerning operation and his heart condition "Prophylactic" digitalization is not necessary For proper choice of anesthesia, see below

Treatment of Cardiac Complications During or Following Operation (1) For carotid sinus syndrome, use atropine (2) For paroxysmal rapid heart action—(a) auricular fibrillation use quinidine, 0 4 gm, intramuscularly at once and repeat every hour until the paroxysm ends (b) auricular flutter use 1 6 mg cedinalid or 1 2 mg digitoxin intravenously slowly, but only if the patient has not been taking digitalis If he has been taking digitalis, give quinidine as for auricular fibrillation, (c) paroxysmal auricular tachycardia try carotid sinus stimulation If ineffective, digitalis or quinidine as for (a) and (b), (d) paroxysmal ventricular tachycardia use quinidine, 0 4 gm, intramuscularly at once and repeat every hour until the paroxysm ends (3) For anginal pain give nitroglycerin, 0 3 mg, sublingually or morphine sulfate, 8 mg, subcutaneously (4) For acute dyspnea, including cardiac asthma and pulmonary edema (a) insure proper ventilation and oxygenation, (b) morphine sulfate, 0 01 gm, and atropine, 0 04 mg, subcutaneously, (c) raise head of patient if possible (5) Cardiac standstill massage heart through diaphragm

To minimize cardiac complications during operation maintain blood pressure at a normal level maintain free airway and good oxygenation and replace blood loss promptly

Postoperatively, the following conditions may interfere with proper cardiac function abdominal distention, ascites, pleural effusion urinary obstruction abnormally low blood pressure or shock, blood loss dehydration, excessive hydration, especially if sodium chloride is given, paroxysmal rapid heart action, infection, uncontrolled diabetes, acidosis, hypoglycemia, failing renal function, atelectasis

Anesthesia

Anesthesia, skillfully administered, is much more important than the choice of anesthetic agent

General Anesthesia Ether is suitable for all cardiac patients except those with pulmonary congestion Gas oxygen is to be avoided when prolonged anesthesia is required Cardiac patients tolerate transient high grade anoxia better than sustained partial anoxia Cyclopropane is satisfactory in all types of heart disease except for those patients with thyrocardiac disorders, those with arrhythmias or those likely to develop arrhythmias and those who may require epinephrine Pentothal sodium is suitable when brief anesthesia is required It depresses respiration Oxygen inhalation should be given prior to and during injection Avertin may be used for basal anesthesia, but not in patients with arrhythmias or those who may require epinephrine

Regional Anesthesia (local and nerve block) Be sure there is no epinephrine in the novocain, especially if the patient has angina pectoris or hypertension

During anesthesia anoxia should be avoided, as far as possible The oxygen intake should be adequate to produce a normal color of blood and tissues It should be borne in mind that as soon as cyanosis can be detected with the naked eye, the oxygen saturation is already one third below normal If changes in pulse rhythm occur, lighten the anesthesia or change the anesthetic The blood pressure should be maintained with neosynephrin, if needed

CHAPTER 37

DIABETES MELLITUS

Diabetes mellitus is due to inadequate insulin production and a resulting decreased ability to regulate carbohydrate metabolism The decreased reserve of the pancreas is further lowered by age and the strains of obesity, hyperpituitarism, hyperthyroidism or hyperadrenalism When insulin production approaches a critical level (some 25 per cent of normal), postprandial hyperglycemia appears This phase may last months to years At this stage, the fasting blood sugar may be normal and the diagnosis rests on an abnormal glucose tolerance test The islet tissue of the pancreas is working at top speed The load on this tissue is reduced by reducing the total of glucose-producing substances in the diet, especially free sugar ("sweets"), so as to allow rest and the possible regeneration of islet tissue

If neglected at this stage, the islet reserve will be further lowered so that it cannot take care even of the fasting carbohydrate metabolism This is the stage of decompensation, the violence of which depends on the metabolic level, insulin resistance (increased in hyperthyroidism, hyperpituitarism, infection, operative procedures, age) and the variable ability of the patient to burn fat The ability to burn fat without producing excess ketone bodies is limited to 2 5 gm /kg /diem at rest (i e , 150 gm or 1350 calories in a 60 kg person) Since activity requires a larger energy uptake from fat, ketosis occurs Ketosis increases metabolic rate and insulin resistance so that even less carbohydrate is metabolized A vicious cycle of acidosis results Hyperglycemia and glycosuria then occur after each meal and persist to the next meal, so that in days, weeks or months a gradual increase in the blood sugar level occurs Hyperglycemia and acidosis both produce distortions in water and salt exchange, and ketosis results in gradual or rapid decrease of blood *p*H, a decrease of blood carbon dioxide and loss of sodium and potassium Shock due to dehydration then follows and with it the serum protein falls There is already a depletion of the body's labile and stable protein reserves

The treatment of diabetes depends on the severity In the stage of compensation the daily caloric intake (25 to 30 calories per kg),

which aims to reach and maintain an ideal weight, is met by 80 to 90 grams of fat, 1 gm /kg of protein and the rest as carbohydrate (130 to 250 gm) Free sugar containing foods are restricted in diabetic diets so as to avoid quick assimilation They produce postprandial hyperglycemia or glycosuria within two hours after meals Therefore, it is always important to specify "diabetic" in prescribing a diet for these mild cases To attain ideal weight a lower caloric diet may be necessary at first Insulin is added where necessary Because the carbohydrate metabolism is least well controlled in the morning, less carbohydrate (one fifth of the daily total) is given at breakfast, and two fifths at each of the other two meals

Regular insulin is given one half hour before breakfast Although it acts for only four hours, the effect of lowering the before noon blood sugar toward normal is to improve the noon and evening tolerance and to avoid excessive hyperglycemia Patients with severe diabetes may require globin insulin, which acts for about twelve hours and therefore suffices for all three meals The peak of its action occurs in the middle of the long afternoon fast and the added beneficial effects of exercise may result in a 4 P M hypoglycemia Hence a small feeding is added at 3 P M for patients receiving globin insulin Most patients who require globin insulin or multiple doses of regular insulin usually have insufficient endogenous insulin to keep even the night fasting glucose level normal If this is high, they receive protamine zinc insulin (P Z I), which acts for twenty four hours Since the twenty four hour action is so advantageous physiologically, in actual practice the great majority of patients, with severe or mild disease, now receive this type of insulin The most severely ill require over 40 units of P Z I daily In the regulation of the more severe cases, it is helpful to follow the urine sugars before and two hours after each meal and at 9 P M It is important to discard the first morning urine in order to get a true fasting urine

The long term objective aims at maintaining a normoglycemia in order to prevent or delay long term complications such as premature arteriosclerosis, cataracts, retinitis, etc

CARE OF SURGICAL PATIENT WITH DIABETES

This involves more immediate considerations as follows (1) All diabetic persons over forty or who have had five or more years of diabetes are suspect of significant coronary disease (2) The diabetic liver lacks a normal glycogen reserve and is still further depleted if there is thyrotoxicosis or gallbladder disease (3) Since even well

regulated diabetic patients require vitamin B complex supplements, the vitamin deficiency in the poorly regulated diabetic patient or one debilitated by disease, infection or thyrotoxicosis is even greater, so that a visible deficit in the form of a partially or totally smooth red tongue may be present The additional burden of an operation may throw the patient into frank deficiency, retarding healing (4) The poorly regulated patient with diabetes is deficient in salt and protein and, therefore, more susceptible to shock If shock occurs, the resulting renal impairment aggravates the fluid and electrolyte imbalance Acidosis and ketonuria must be eliminated The acidotic patient is in a state of emergency requiring insulin, treatment of dehydration by saline solution and blood or plasma for secondary shock

Mild "green or olive green" glycosuria is the best compromise (1) in those whose diabetes is unstable, as in infection or thyrotoxicosis, (2) in coronary disease, where hypoglycemia is to be avoided

Accordingly, the *preoperative preparation of diabetic patients* includes (1) electrocardiogram, (2) several days of high vitamin B intake and, where needed, increased salt, protein and sugar intake If there is renal impairment, the blood sugar two hours after a meal should be known

Any patient who has or has had glycosuria should have a glucose tolerance test to establish the presence or absence of diabetes

Coma is a contraindication to surgery, except in the rare circumstances when it is clear that the immediate drainage of a septic focus is essential for recovery from coma In *severe acidosis*, control of the diabetes may be impossible without drainage of a septic focus The severity of the acidosis is proportional to the amount of diacetic acid in the urine Except for the special condition of acute severe sepsis, surgery should be delayed until the diabetic state is under control

The primary preoperative objective in the medical management of diabetes is the restoration and maintainance of a sufficient glycogen reserve in the liver If this is achieved, the surgeon should not and need not insist on a normal blood sugar level or a urine entirely free of glucose The time of operation is then dependent only upon the urgency of the surgical condition

Operative and Postoperative Care

(1) Operations on patients with severe diabetes should be scheduled early so that if hypoglycemia develops from insulin given early in the morning it will not be masked by the premedication or the

anesthesia, and will be recognized and treated promptly (2) In such cases one half the P Z I dose, 10 units of regular insulin and a glass of orange juice should be given some three hours before operation If a regular breakfast is permissible, it should be given If oral alimentation is contraindicated, intravenous glucose is given, together with 1 unit of insulin for every 3 grams of glucose The fluid should run in slowly so as to permit full utilization Administration of 1000 cc of 5 per cent glucose should take more than one hour (3) Give morphine and barbiturates sparingly because they may mask dangerous hypoglycemia or acidosis (4) In the presence of infection and during or after operation, it is preferable to have the patient spill + or ++ sugar without acetone (5) Regular insulin is used as the glycosuria and acetonuria require, with a basic dose of P Z I in severe cases (6) Salt is given as for patients without diabetes (7) Shock is especially hazardous in the diabetic patient (8) Postoperatively, in order to minimize depletion of glycogen reserves and the resulting incomplete combustion of fats, 100 to 200 grams of glucose daily for the first few days should suffice and is given in whatever form the patient can take it (9) Regular insulin is supplied according to the color of the tested urine red, 15 units, orange, 10 units, green or yellow, 5 units, blue, a glass of carbohydrate drink Catheterization should be resorted to, if necessary, to obtain urines If there is bladder atony, constant drainage is needed in order to follow glucose excretion closely (10) The blood glucose level need not be determined postoperatively unless (a) the urine is sugar free and there is danger of hypoglycemia, (b) acidosis persists and more insulin is needed (the carbon dioxide combining power should also be known because if it is too low, much more insulin will be required), (c) marked glycosuria occurs, in which case better regulation of therapy requires guidance from the blood glucose level, (d) the patient's condition is serious and the cause is obscure (11) As soon as possible give the patient a three meal 150 80 80 diet and switch entirely to P Z I Vitamin B is given parenterally along with glucose and amino acids when necessary (12) The increased insulin requirement of infection will drop after evacuation of a focus of pus, but will not if an undrained focus persists After thyroidectomy, the insulin requirement falls Hypoglycemia may result unless the insulin dosage is reduced

Anoxemia must be avoided Therefore, spinal, local, cyclopropane and ethylene are the preferred anesthetics Ether is less desirable than local or spinal anesthesia, since it produces prolonged unconsciousness, acidosis, some depletion of glycogen reserves and nausea and vomiting

DIABETIC CHILDREN

In childhood, diabetes is characterized by greater average severity and by greater lability of the carbohydrate metabolism Usually insulin is needed Neither insulin nor carbohydrate can be omitted safely for any length of time For long term regulation, morning P Z I and regular insulin will usually be necessary Ketosis and coma occur easily, partly because of low liver glycogen reserves and partly because of the ready occurrence of dehydration and electrolyte imbalance Children are more susceptible to hypoglycemia, especially at night, if large doses of insulin are required The diet must be adequate for growth as well as for the diabetes The caloric needs are 1000 at the age of one, plus 100 calories for each additional year The carbohydrate protein fat ratio is 2 1 1

GENERAL RULES

A newly discovered diabetic patient should be informed of the diagnosis without equivocation, emphasizing that this is a lifelong, permanent disease compatible with good health and normal activity, provided proper care is employed It is important not only to give the patient precise dietary directives, but to teach him (a) dietary principles, (b) insulin administration and (c) the urine test, to be done before breakfast and two hours after the evening meal

CHAPTER 38

COMMON SKIN DISORDERS

SOME ASPECTS OF THE PHYSIOLOGY OF SKIN

The keratin of the stratum corneum is characterized by its high resistance to acid, alkalis and ferments. The thickness and the physical, chemical, actinic, thermal and bacterial resistance of the stratum corneum varies widely, depending on the age, sex, region, constitutional and conditioning factors, and the local requirements. The corneum responds to any kind of continued irritation, which does not disrupt the surface, by proliferation, as, for example, keratosis of the seaman's or peasant's skin from exposure to weather, the callus on the palm of the worker or on the knee of the charwoman. Its thickness also influences the pathogenesis of certain skin conditions, for instance, in scabies the sarcoptes cannot penetrate the heavier horny layers and prefer areas with minor cornification, as the interdigital aspects of the fingers, the volar aspects of the wrists and forearms, the male genitals and the perimammillary region in females. They are almost never found on the palms of adults, but they do invade the palms of infants and children. Allergic epithelial manifestations like pityriasis rosea and certain bacterial "id" reactions spare heavier cornified areas. The higher incidence of impetigo contagiosa and cutaneous herpes simplex in children and women than in men is partly, if not entirely, due to the lesser thickness of the horny layers.

The protective and defensive power of the stratum corneum is considerably strengthened by its coating of, and impregnation with, a complex greasy mixture of neutral fats, free fatty acids—particularly oleic acids—soaps, cholesterol and other lipoids. This mixture is derived mainly from the sebaceous glands and to a lesser extent from the deeper epidermal layers.

The sebaceous glands are *holocrine glands*, i.e., their cellular elements disintegrate in the process of making the fatty mixture and are continuously replaced by new cells. This transformation must not be confused with fatty degeneration; it is a normal biological process, probably governed by enzymatic action of the B group of vitamins and by the endocrine glands, particularly the sex glands.

The composition of sebum is not related to the amount or type of fat or carbohydrate ingested or present in the circulating blood These glands, however, excrete certain drugs, such as iodine, bro mine, morphine, antipyrine, and the aromatic component of ingested substances (garlic) and of intestinal end products A similar excre tory activity occurs in the only other holocrine gland of the body, namely, the mammary gland

The striking similarity of the secretory mechanisms of the mam mary and sebaceous glands is certainly more than coincidental The development and function of both are regulated by hormonal in-fluences, particularly of the sex glands The sebaceous glands, like the mammary glands, undergo marked enlargement and functional stimulation during puberty and regression after the endocrine functions of the sex glands have ceased New sebaceous glands de velop during puberty in the vulva, internal aspect of the prepuce, the nipple and anus One archaic, yet not completely extinct, function of the sebaceous glands is the excretion of substances which release a specific odor to attract the sexual partner Hence the sebaceous glands, like the mammary glands, are in fact secondary sex organs

These considerations can be applied even more aptly to the func tion of the *apocrine sweat glands* They are present only in the genitocrural, perianal, axillary and areolar regions, where they ap pear and develop during puberty and regress after the climacterium They appear in greater number and size in females than in males, showing marked secretory and histologic changes during the men strual cycle Thus hydrosadenitis occurs more frequently in women than in men, but never before puberty and rarely after the climacte ric The apocrine sweat glands differ in many respects from the *eccrine sweat glands,* which are found in the skin over the entire body They are considerably larger than the eccrine glands and empty their secretion, as do the sebaceous glands, in the immediate neighborhood of or more often directly into a hair follicle, while the narrow ducts of the eccrine sweat glands have no connection what-ever with hair follicles Whereas the cellular structure of the eccrine glands remains unchanged during the entire secretory process, the apocrine glands combine features of the eccrine and holocrine secre tion, in that a part of the cells is transformed to a fatty mixture simi lar to that of the sebaceous glands, containing an even larger amount of aromatic substances The addition of this mixture of neutral fats, alkaline soaps free fatty acids and traces of cholesterol to the sweat causes a considerably lower acidity of the axillary, inguinal and perianal perspiration, compared with that of the sweat in other re

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scratching or unnecessarily vigorous preoperative scrubbing of the skin, will have the same consequences The axillary, genitocrural and perianal regions are particularly susceptible to bacterial and mycotic dermatoses, because of the relatively high *p*H of the apo crine sweat, which easily shifts to the neutral or alkaline side in re sponse to even slight maceration Uncleanliness or the application of heavy nonhygroscopic ointments and caking powders (zinc and starch powders) promote maceration and, in addition, are apt to block the large follicular openings, causing secretory obstruction and retention with resulting intra , perifollicular and glandular inflammatory reaction Hence, acidified water or alcohol, oint ments containing hygroscopic kaolin and anhydrous lanolin ("Desi tin" ointment) and acidified U S P talcum are the optimal topical medications for these areas

The sudoriferous and sebaceous glands add a protective function to that of the stratum corneum, which must be regarded as an organ for protection and defense The epidermis serves to maintain the structural and functional integrity of the stratum corneum and should be regarded as the parenchyma of the skin by virtue of its numerous functions pigment formation, activation of Vitamin D, regeneration, production of histamine, etc The corium, which con tains an essential part of the reticulo endothelial system, provides the raw material for these purposes It mobilizes the cellular elements indispensable for the defense against and repair of injuries and infections and contributes considerably, by its particular structure (elastic and connective tissues), to the mechanical requirements of the skin

DRUG REACTIONS

Bromides acneiform, vesicular, pustular and erythema multi form like eruptions, particularly on the legs High bromine level in plasma

Iodine and Iodides similar to bromide eruptions and angio neurotic edema

Quinine scarlatiniform and purpuric exanthem and enanthem

Salicylates morbilliform, scarlatiniform, erythematous, urticarial, erythema multiform like eruptions, angioneurotic edema and conjunctivitis

Phenolphthalein fixed violaceous, purpuric and erythema multi form like eruptions

Barbiturates and Dilantin morbilliform, scarlatiniform, urticarial and purpuric eruptions, multiform and bullous enanthem

gions of the body The *p*H of the sweat of the eccrine glands is acid, varying from 3 8 to 5 6, that of the apocrine is almost neutral, varying from 6 2 to 6 9

This difference is of great significance in the pathogenesis of many skin diseases The maintenance of a certain *p*H on the cutaneous surface is indispensable for the prevention and treatment of bacterial and mycotic skin infections The acidity of the normal epidermal surface varies between a *p*H of 3 2 and 5 2, according to the region, the physiologic and environmental conditions, age and sex of the individual This acid reaction, the protective "acid coat of the skin"

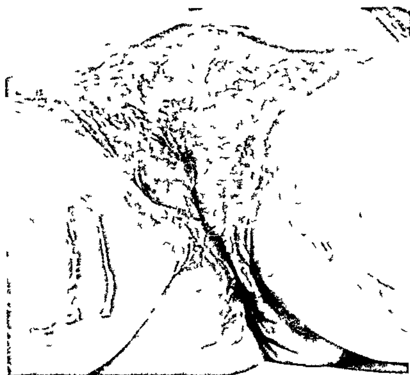


Fig 32 The diagnosis of the lesion in the right inguinal region was first considered to rest between lymphopathia venereum and tuberculosis It was eventually correctly diagnosed as hydrosadenitis and yielded promptly to the appropriate therapy

is due mainly to the oxidation processes accompanying keratinization, to the acid sweat and the fatty acids of the sebum The acidity becomes progressively lower in the deeper parts of the epidermis and decreases considerably in the corium Maceration of the stratum corneum from repeated or continued soaking in alkaline or neutral solutions, increased perspiration without adequate evaporation, particularly in the intertriginous and interdigital regions or beneath impermeable dressings, reduces the protective acidity and promotes cutaneous infections Superficial injuries of the stratum corneum or denudation of the deeper layers of the epidermis or corium by

are the webs of fingers, volar aspects of the wrists, anterior axillary folds, perimammillary areas, umbilicus, penis, scrotum and buttocks In children, palms and soles

Treatment "Benzyl Benzoate Emulsion" (Burroughs Well come) Mix with equal parts of water and apply vigorously with a stiff shaving brush for five minutes after thorough scrubbing with soap and water Allow to dry and remove in bath after twenty four hours

INTERTRIGINOUS DERMATOSES

Moniliasis

(Due to *Candida albicans*)

Diagnosis Erythematous, macerated, sharply defined patches with peripheral vesiculopapules and small pustules Typical sites Submammary, intergluteal, perianal, perivulvar, axillary and retro auricular regions, abdominal folds, interdigital webs between ring and middle fingers and the nail folds, producing chronic paronychia More common in females than in males Contributing factors sweating, wet dressings, obesity, diabetes mellitus, vitamin B de ficiency

Treatment

℞	Conc Hydrochloric acid (U S P)	0 24 cc
	Distilled water	52 0 cc
	Mix and add	
	Mercurochrome	1 8 cc
	dissolved in Glycerin	6 0 cc

Mix Sig Apply with cotton swab every eight hours beyond margins of involved areas allow to dry Insert dry sheeting in folds

Eczema Marginatum or Tinea Cruris

(Due to *Epidermophyton inguinale*)

Diagnosis Brown to bright red patches, isolated or coalescent, with circinate elevated margins and scaling central parts Usual sites genitocrural region, perineum, intergluteal, perianal and axillary areas More frequent in males than in females

Treatment Do not use ointments or shake lotions

℞	Salicylic acid	0 6 cc
	Iodine crystals	0 9 cc
	Alcohol (9 per cent)	25 0 cc
	Ether	20 0 cc

Mix Sig Apply with swab b i d

Sulfonamides urticarial, morbilliform, hemorrhagic, erythema multiform or nodosum like eruptions, hemorrhagic, bullous en anthem

Penicillin urticarial, edematous, vesiculous, bullous, varioliform exanthem and enanthem

Treatment Omit suspected drug Topical treatment depends on the particular form of eruption, for instance, for itch—cooled talcum powder or 2 per cent pyribenzamine in a water soluble base, for vesicular, bullous and erythema multiform like eruptions—cold compresses of Burow's solution (1 part in 12 parts of water) or sponging with potassium permanganate solution (1 15,000 to 1 30,000), for pustular or variola like eruptions—compresses with warm 3 per cent boric acid solution, for iodine or bromine eruptions—highly salted foods or 10 to 15 gm of sodium chloride daily in enteric coated tablets

HYPERSENSITIVITY REACTIONS

These are caused by disinfecting solutions, soaps, adhesive tape, local anesthetics Inquire into past history and, if possible, perform skin tests, particularly for iodine and adhesive tape sensitivity

Treatment for erythematous reactions

℞ Zinc oxide or Talcum	
Glycerin	āā 30 0 cc
Burow s solution	10 0 cc
Distilled water	ad 120 0 cc

Mix Sig Apply b i d and allow to dry

"Sheet-rash" This is due to residual chlorine and soap in bed linen Erythematous, urticarial, papular, vesicular and eczematous Usual distribution extensor aspects of upper arms, elbows, buttocks and knees

Treatment Soak bed linen in clear water for several hours after customary laundry procedure

Pediculi Pubis Apply "Cuprex" (Merck) with a paint brush Remove Cuprex with soap and water after six hours Repeat if necessary after forty eight hours

Pediculi Capitis Inspect for nits Soak hair with "Cuprex" and cover head with cap In children, wash with soap and water after three hours, in adults after twelve hours Then wash hair with warm vinegar on three successive nights and use fine comb while hair is still wet

Scabies Diagnosis burrows, miliary papules, pyodermic and eczematous lesions, scratch marks, nocturnal itching Preferred sites

PRURITUS ANI

Since this condition is occasionally referred to the surgeon for treatment, an understanding of the principles involved is essential The causes of the complaint are varied Parasites such as pinworm, ascaris, pediculi and *Trichomonas vaginalis* may act as local irritants Other local irritants are fissure, fistula in ano, external or prolapsing hemorrhoids, stool residues, mineral oil, cathartics, local medicaments and the mechanical friction from the use of enemas, toilet paper and homosexual and masturbatory practices The itching may be due to local skin diseases fungus infection, particularly moniliasis and trichophytosis, psoriasis, lichen planus, seborrheic dermatitis, herpes simplex, hyperhidrosis and neurodermatitis Constitutional disorders such as diabetes, vitamin B deficiency, jaundice, pregnancy, hepatic cirrhosis and the menopause also produce pruritus ani Psychological factors such as anal eroticism, latent homosexuality and habitual scratching may initiate the disorder

Each of these causes separately or, more often, several of them together, may provoke pruritus Continuous and eventually habitual scratching induces local cutaneous changes which may conceal the primary cause

Treatment must be based on a careful consideration of all etiologic factors and managed accordingly Initial symptomatic treatment (cool 3 per cent boric acid compresses, or ½ per cent resorcinol solution for inflammatory reaction, Grenz or x ray therapy for chronic induration) is followed by causative therapy Local anesthetics and hypnotics are not desirable Dilatation of the sphincter, alcohol injection and undercutting procedures for the treatment of pruritus are futile and often produce more harm than good In other words pruritus, in itself, is not a surgical disorder

After drying apply the following powder

℞	Boric acid	9 0 cc
	Precipitated sulfur	6 0 cc
	Kaolin	10 0 cc
	Talcum	ad 150 0 cc

Mix Sig Apply b i d after drying

After treatment is necessary for many weeks to prevent maceration Use

℞	Conc Hydrochloric acid (U S P)	0 6 cc
	Liquor carbonis detergens (Wright)	15 0 cc
	Glycerin	9 0 cc
	Alcohol (70 per cent)	ad 150 0 cc

Mix Sig Apply several times daily

Erythrasma
(due to *Microsporon minutissimum*)

Diagnosis Brown or reddish brown, very sharply defined, non indurated, superficially exfoliating eruption Typical localization genitocrural and, less frequently, axillary folds Much more common in males than in females

Treatment Iodine lotion as for eczema marginatum

After treatment necessary

℞	Salicylic acid	
	Resorcinol	āā 1 5 cc
	Alcohol (70 per cent)	ad 120 0 cc

Mix Sig Apply b i d and allow to dry

Psoriasis

Intertriginous psoriasis differs from the common type in that the lesions are usually redder and macerated lack desquamation and form deep and extremely painful fissures in the involved folds The usual localization is submammary, umbilical, axillary, retro auricular, genitocrural or, most frequently, the coccygeal and perianal regions Typical extensor involvement on elbows and knees may or may not be present If perianal psoriasis is the only cause of anal pruritus, avoid elective surgical procedures

Treatment Since superinfection with *Candida albicans* is not uncommon, start with acidified mercurochrome solution (see above) and continue for one week Thereafter, use the usual antipsoriatic treatment The metaplasia of the epidermis in this disease suggests that withdrawal of vitamin A or carotene from the diet may be therapeutically helpful

During normal flow more blood traverses the cortex than the medulla and flow is slower in the latter, although distributional fluctuations in response to varying needs for adjusting fluid and electrolyte balance probably also occur When the neurovascular reflexes are stimulated abnormally, the cortex pales, the medulla becomes congested and arterial blood can be seen leaving the kidney via the main renal vein The caliber of the vessels composing the renal by pass is not responsive to these neurovascular reflexes If the ischemia induced in the cortex is sustained, the juxtamedullary glomeruli receive most of the blood and the filtering capacity of the cortex is reduced, so that oliguria results The uremia and oliguria or anuria of crush syndrome, incompatible blood transfusion, certain types of severe sepsis, bilateral cortical necrosis, renal shutdown following unilateral renal surgery, etc , may be due to the operation of this mechanism Even the antidiuretic effect of pituitrin, which has been attributed to a specific effect on the absorptive capacity of the tubular cells, is more probably due to diversion of cortical flow (From the foregoing it follows that clearance tests of glomerular function cannot be utilized as a measure of total renal flow) The abruptness with which spontaneous diuresis sometimes begins after suppression is possibly due to sudden release of the ischemia by reflex vasodilatation of the cortical vessels

The mechanism of diversion of cortical flow may operate in the genesis of the hypertension which develops during acute renal failure and in essential hypertension The sensitivity of the neurovascular reflexes in response to emotional or other stimuli may produce intermittent or sustained cortical anoxia with the resulting elaboration of the pressor principle The fall in blood pressure achieved by sympathectomy in hypertension not caused by organic renal disease may be in part attributable to obliteration of such reflex effects In organic renal disorders associated with hypertension there is some evidence that, in the absence of disease in the large vessels, reduced flow through the cortex may stem from decreased resistance in the by pass as a result of conversion of the capillary tufts of the juxtamedullary glomeruli into single enlarged straight communications between afferent and efferent arterioles to form the so called arteria vasa recta characteristic of the chronic vascular nephritis of old age

Determination of Renal Status

Determine the renal status by the presence or absence of edema, hypertension, retinal vascular disease, cardiac enlargement and by urine analysis Quantitate the urinary albumin and study the sedi

CHAPTER 39

RENAL DISORDERS

(See Chapters on Fluid and Electrolyte Balance and on Urologic Disorders)

The recent demonstration by Truetta and his collaborators* of a dual circulation in the kidney provides a better understanding of the pathologic physiology of renal disorders in which oliguria or anuria is a predominating feature These workers demonstrated that renal blood flow is subject to control by neurovascular reflexes initiated by trauma to an extremity, by direct stimulation of a large somatic nerve or the splanchnic nerves or by a circulating toxin A decline in renal flow apparently can be induced by less intense stimulation also, for changes in urine output can occur as a result of emotional stress, muscular exercise, epinephrine, pyrogens, pitressin, pituitrin and other factors These agents produce vasoconstriction either of the renal artery so as to reduce overall flow or, selectively, of the cortical vessels so as to divert much of the blood normally reaching the cortex to the medulla This diversion of flow, in the experimental animal, can be prevented by splanchnicectomy

Such diversion of flow is possible because of the special anatomy of the intrarenal circulation The glomeruli of the peripheral part of the cortex differ from those in the juxtamedullary region in that the efferent arteriole of the former is smaller than its afferent, while the efferent arteriole of the latter is larger than its afferent The efferent arteriole of the former divides into capillaries which are distributed among the tubular structures in the immediate neighborhood The efferent arteriole of the latter drains into the straight vessels (vasa recta) of the medulla The latter vessels run down parallel and close to the descending loops of Henle and the collecting tubules in the medulla, then turn back at varying distances from the pyramid to empty, like the shorter veins of the cortex, into the arcuate veins lying between cortex and medulla The large caliber of the efferent vessels leading to the vasa recta provides a ready by pass for diversion of flow from the cortex That this in fact occurs was demonstrated by various methods of visualizing the blood stream

* Truetta J et al Studies of the Renal Circulation Charles C Thomas Springfield Illinois 1947

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or the albumin globin ratio too often fail to show deviations consistent with the development of fluid retention

Surgical Risk Patients with renal disease who void 1500 to 2000 cc of urine in each twenty four hour period are fair surgical risks If urinary output falls below this volume, impaired renal function may be converted to renal insufficiency by surgical trauma

Preoperative Preparation If oliguria is present, all operative procedures except emergencies are contraindicated until the oliguria is corrected If the oliguria is associated with edema caused by renal, in contrast to prerenal, disorders, it may be difficult to do this and operation should be delayed until diuresis occurs

The hypoproteinemia of nephrosis may interfere with wound healing Such patients are not good surgical risks and only emergency operative procedures may be undertaken

The choice of anesthetic must be left to the judgment of a qualified anesthetist The anesthetic should avoid large shifts in blood pressure An adequate urinary volume and an effective blood pressure must be maintained throughout the postoperative period Daily urine and nonprotein nitrogen determinations may be needed to observe the progress of renal function Sulfonamides should not be used if nitrogen retention is present Excessive sodium chloride must be avoided Transfusion reactions are especially dangerous

Treatment of Renal Suppression and Azotemia

If there is oliguria, see that dehydration is not responsible Prostatism and other forms of mechanical obstruction, such as operative damage to ureters, may account for it If congestive heart failure develops, give digitalis and order a salt poor regimen For oliguria due to shock, see section on Traumatic Shock, Chap 4 The azotemia observed after gastro intestinal hemorrhage has been attributed to the absorption of a large amount of digested blood protein This may be true in severe bleeding, but in any case, such an azotemia is not likely to be persistent More probable causes are shock and the starvation and dehydration associated with the hemorrhage The azotemia associated with pyloric obstruction is due to dehydration, but the alkalosis also is said to add to the renal injury These azotemias are partly renal and partly prerenal and disappear upon appropriate fluid and electrolyte therapy Severe sepsis may produce oliguria in spite of adequate fluid intake

If oliguria or anuria are due to acute renal injury, whether from incompatible transfusion, crush syndrome, bichloride of mercury or carbon tetrachloride poisoning, acute glomerulonephritis or any other

ment for red and white blood cells, casts and bacteria Culture the urine if there is pyuria Intravenous pyelography should be done to determine the possible cause for pyuria or albuminuria

Renal function may be determined by a study of the specific gravity of the urine, the phenolsulfonphthalein test and the blood nonprotein nitrogen

Interpretation of Tests of Kidney Function

Normal renal function is present if the urinary specific gravity is 1 024 or higher by concentration tests, and if the fifteen minute phenolsulfonphthalein excretion is 25 per cent or higher

Impaired renal function is present if the maximum urinary specific gravity is less than 1 020, the fifteen minute phenolsulfonphthalein excretion is below 15 per cent while the blood nonprotein nitrogen is normal

Renal insufficiency is present if the maximum urinary specific gravity is below 1 012, the fifteen minute phenolsulfonphthalein excretion is below 15 per cent and the blood nonprotein nitrogen is above 40 mg per 100 cc

If hypertension is present, obtain daily basal blood pressure readings, do a retinal examination and determine heart size and function Inquiry should be made regarding previous cerebrovascular episodes, visual impairment, symptoms of congestive heart failure and chest pain of coronary origin Electrocardiographic examination may contribute significant data

If edema is present, one must establish its origin nephritic, nephrotic, nutritional or cardiac Determinations of the serum total protein, albumin and globulin and blood cholesterol will be helpful in differentiating nephritic from nephrotic edema In the latter the total serum protein and albumin are low and the cholesterol is high Nephritic edema is usually associated with hematuria Cardiac edema is associated with the usual signs and symptoms of congestive failure

The edema of cardiac disease, which heretofore has been attributed to increased venous pressure resulting from failure of the right side of the heart, is considered by some investigators to be due to tubular damage of the kidney, such that sodium is excreted in a less than normal proportion to chloride Sodium retention results and with it water retention Whether this is true or not, a low sodium intake is indicated to reduce the edema

The same phenomenon is said to explain ascites or generalized edema of hepatic cirrhosis, in which the values for serum total protein

SECTION V

Clinical and Laboratory Methodology

toxic agent, it is not only useless but decidedly *dangerous to try to force diuresis by giving fluids* In these circumstances pulmonary edema as well as generalized edema will be created if more than the water lost by vaporization is given Not more than 1000 cc of fluid daily is permissible and this should be glucose in water Even this amount is omitted if there is edema Concentrated glucose may then be given by slow drip and acidosis treated by intravenous sodium bicarbonate Sodium chloride is omitted unless there is severe loss of sodium through an intestinal fistula, diarrhea, vomiting, etc A moderate loss of chloride is not harmful and need not be replaced Blood or plasma for anemia may also be given Spontaneous diuresis will occur in a substantial number of patients after a period varying from several days to weeks, providing the situation is not made worse by unwise therapy

If diuresis does not occur and the patient is getting rapidly worse, one may resort to renal decapsulation, splanchnic denervation, dialysis by Kolff's artificial kidney or peritoneal irrigation to maintain life during the period of renal suppresion, until sufficient function has returned It is extremely difficult to determine when such measures should be instituted If harm is avoided by preventing edema, correcting anemia, plasma loss, acidosis and hypocalcemia and giving glucose in maximal amounts consistent with the need for restricting fluids, many patients will survive anuria lasting as long as two weeks and recover spontaneously Such conservative therapy is certainly to be preferred to the above heroic procedures, if a proper judgment can be reached as to how long it is safe to wait before using them If the patient has been put into critical condition by overzealous unwise therapy, it may be necessary to resort to rapid dialyzing technics *

When diuresis occurs upon resumption of renal function, it is likely to become a polyuria In that case the salt lost with the water may be excessive and replacement of salt deficiency will be required

* Frank H A, et al Annals of Surgery *128* 561 1948

CHAPTER 40

THE BLOOD BANK AND BLOOD GROUPING TECHNICS

BLOOD BANK

The purposes of a blood bank are (1) to provide an adequate supply of bloods of all groups and types, (2) to provide an adequate supply of plasma and (3) to minimize the use of professional donors

The personnel of a blood bank includes a director, nurses who are directly responsible to him and who are trained in the technic of collecting blood and preparing plasma, and laboratory technicians who are responsible for the grouping and typing of blood and for compatibility tests

The bank nurses are responsible (1) for the supply and maintenance of equipment for drawing and administering blood, (2) for issuing and receiving blood from and to the bank, (3) for the preparation of acid citrate dextrose preservative solution, (4) for the drawing of blood from donors, (5) for the preparation of sterile plasma from expired bloods, and (6) for the maintenance of the bank and its record book

The person who draws blood from a donor is responsible for numbering the blood flask and its attached test tubes and for filling out *in detail* that part of the blood transfusion card pertaining to the blood donor

The bank nurse or doctor who draws the blood should take a pertinent though brief history of the donor An appropriate physical examination should be done also A physical examination is particularly important when the blood is to be used fresh and without refrigeration Oral temperature and a hemoglobin determination is required of all donors The donor's hemoglobin must be 12 3 grams per 100 cc or higher

Suitability of the Donor Donors must be in good health They should be specifically questioned with regard to the following, past or present malaria or residence in malarious areas, syphilis, gonorrhea, venereal disease, jaundice, bronchitis, asthma, hay fever, allergy, stomach ulcer, rheumatic fever, angina pectoris, heart

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disease, fainting spells, epilepsy, tuberculosis, undulant fever, chronic illness or any illness including operations within the last two years If any answer to these questions is positive or equivocal, the donor may not be acceptable

Donors are instructed beforehand not to take food for at least four hours before donating Shortly before the blood is taken, coffee or tea, clear broth, fruit juices, crackers or toast, sugar and jam may be taken but *cream, milk, butter, cheese, nuts, ice cream or eggs may not be taken for four hours before the blood is taken*

AGE LIMITS Eighteen to sixty years Donors over sixty years old should not be accepted Donors between the ages of eighteen and twenty one should have signed permission from a parent or guardian

The donor is instructed that he or she is being asked to give blood for his relative or friend He is to be told that if his blood can be used for the relative or friend, it will be so used, but if it is not compatible, his written permission is asked to use it for someone else who may need it

Ordinarily 500 cc of blood is drawn, with intermittent shaking, into a refrigerated Fenwal flask containing A C D solution After the Fenwal flask has been filled, three test tubes provided with each flask should be filled with blood and stoppered These, plus a fourth empty test tube, should be properly numbered with the same number as the Fenwal flask One tube goes to the laboratory for blood serology A second tube is attached to the Fenwal flask, which is then placed in the bank refrigerator The third tube and the fourth empty one go to the laboratory for grouping and cross matching tests

The bank refrigerators are maintained at a temperature of 3 9° to 6 1° C by appropriate thermostats Deviations above or below this temperature should set off an alarm bell

The label on each blood sample should be marked clearly with its number blood group, Rh type, date of collection, expiration date, donor's name and result of the serology test The bloods are stored on separate shelves for each group

Bloods which expire are removed for processing into plasma The plasma processing is done under aseptic precautions The supernatant plasma from not more than three bloods is drawn off into a sterile Fenwal flask, utilizing completely separate equipment for each A 10 cc sample from each plasma flask is taken for culture for aerobic and anaerobic organisms If the fourteen day culture is negative, the plasma is suitable for administration The plasma flask is then numbered and stored in a refrigerator The expiration date of plasma is

eighteen months from the date of bleeding Just before the plasma is used it must be neutralized with 10 cc of blood group specific sub stances to insure a low titer of Anti A and Anti B agglutinins

The oldest blood and plasma are used first, in order to maintain a reserve of the freshest blood and plasma Occasionally there are special indications for relatively fresh blood, as, for example, in hemophilia and in patients with prothrombin or platelet deficiency In rare instances fresh blood exposes the patient to possible trans fusion syphilis from donors who are in the early sero negative phase The danger of transfusion syphilis is essentially eliminated by re frigeration of blood from three to four days

All bloods must be checked for syphilis either by a regular Hinton or Kahn test or by a rapid Hinton or Kahn test Any blood showing a positive or doubtful test is discarded

Precautions against the use of possibly malarious donors are taken as follows if the prospective donor has been in a malarious area and has had an attack of malaria, he should not be used unless at least two years have elapsed since leaving the zone and provided that he then discontinued suppressive treatment (atabrine or quinine) and has not had a recurrence during the two years previous to his dona tion Even so, before donation a thick smear should be examined and found to be negative As this procedure takes several hours, it will usually be necessary to notify the donor to return in another day If the prospective donor has been in a malarious area and has not had an attack of malaria and for the past year has not taken any suppressive treatment, he mav be used, provided a thick smear does not reveal any parasites If this donor gives a history of undiagnosed fever or a questionable history, the first of these two conditions should apply

Blood Grouping and Compatibility
(Cross matching Tests)

All patients who are to have major surgery performed should be tested routinely for the Rh factor as well as for the blood group

Bank bloods are grouped as soon as possible after they have been drawn Grouping by a test for agglutinogens is checked or proof grouped by a test for agglutinins Proof grouping must not be omit ted, as it is an accurate method for selecting group AB bloods with feeble A agglutinogens, as well as for proof grouping in general Bloods, whose agglutinogen and agglutinin content do not match, require retesting Testing serum which fails to agglutinate group AB bloods properly should be discarded

BLOOD GROUPING TECHNICS

Precautions Although the tests are relatively simple, their performance requires a high degree of individual responsibility Extreme care should be exerted to avoid mixing of specimens Five hole wooden blocks will help greatly in this respect All test tubes and slides must be labeled The tubes containing sera and cell suspensions of the donor should be kept on one side of the block and those of the recipient on the other side Both recipient's and donor's blood should be grouped and in addition directly matched, because of the existence of subgroups and atypical agglutinins

False negative reactions may be due to the use of weak group A and B sera, containing insufficient amounts of agglutinins Testing sera should be potent and should be checked against known bloods before use Proper time must be allowed in conducting the tests after mixing cells and serum Too concentrated suspensions of corpuscles may absorb all of the agglutinins in weak or diluted sera and fail to show agglutination Marked hemolysis with masking of agglutination may occur when fresh and highly active sera are utilized The presence of hemolysis without agglutination in the direct matching should be considered equivalent to agglutination

False positive reactions may be the result of pseudo agglutination or rouleaux formation The latter tends to appear at the edges of the slide in the hanging drop technic True agglutination, even when weak, is usually dispersed throughout the slide In the test tube technic rouleaux formation is eliminated by the addition of saline solution Auto agglutination, i e , agglutination of an individual's red cells by his own serum at room or ice box temperature, will disappear if the mixture is warmed to 37° C Sera of this type may agglutinate the corpuscles of all other bloods regardless of the temperature Irregular or atypical isoagglutinins are usually weak and act mainly in the cold and occasionally at room temperature To avoid auto agglutination all testing sera should be approximated to room temperature before using Bacterial contamination may also cause false positive reactions

BLOOD GROUPING BY DETERMINATION OF AGGLUTINOGENS IN THE RED CELL

1 *The Hanging Drop Technic* This is a preferred standard method because it is sensitive and lends itself to confirmation by several observers Agglutinogens in the red cells and agglutinins

in the serum are determined (1) Puncture the ear or finger and collect two drops of the donor's or patient's blood in a small test tube containing 2 cc of saline solution Mix gently (2) Mark a hollow ground slide "A" on one side and "B" on the other Mark the name of the patient or donor in the center (3) Break both ends of a capillary of known group A serum and expel one drop of the contents on to the center of a clean cover slip (4) Add one drop of the corpuscle suspension to be typed, using a wooden applicator Mix gently, keeping the suspension in the center of the cover slip (5) Invert deftly, rotate gently and place it at "A" on the hollow ground slide and seal with paraffin (6) Repeat the same procedure using group B serum and place it at "B" on the other side of the hollow ground slide (7) Allow to stand for three to five minutes, occasionally rolling or tilting the slide to insure thorough mixing Examine macroscopically, and if it is difficult to distinguish between true agglutination and rouleaux formation, roll and tilt the slide again, as this will break up rouleaux to a smooth suspension If true agglutination has occurred at the end of five minutes, a reading and report may be made If there is no agglutination, incubate at 37° C for thirty minutes and examine microscopically and macroscopically for the final reading (8) Readings are made as follows no agglutination by either A and B sera = group O, agglutination by B serum and not by A serum = Group A agglutination by A serum and not by B serum = Group B, agglutination by both A and B serum = Group AB (9) Bank blood is grouped in the same manner Gently rotate an applicator around the clot in the pilot tube to tease out the red cells Then place the applicator in the saline solution and mix gently

2 *The Tube-Grouping Technic* This is a sensitive and rapid method but the sera *must* be of high potency It is an alternative method for blood grouping and proof grouping and for cross matching (compatibility) tests and is of value in checking doubtful results by the hanging drop method

For blood grouping (1) Prepare the cell suspension of the blood as for the hanging drop method (2) Into a Kahn tube labeled A introduce one drop of saline solution and one drop of the unknown cell suspension and one drop of A (Anti B) serum Into another Kahn tube labeled B introduce one drop of saline solution, one drop of the cell suspension and one drop of B (Anti A) serum Agitate gently (3) Centrifuge these tubes at 500 r p m (low centrifuge speed) for one minute Agitate the tubes gently to disperse the sediment and read for agglutination Gross clumping can usually be seen with the naked eye (4) The readings are made as shown in the table (p 384)

BLOOD GROUPING BY DETERMINATION OF AGGLUTININS IN THE SERUM (Proof Grouping)

1 *Hanging Drop Technic* (1) Fill two capillary tubes by capillary attraction two thirds full of the patient's blood, obtained from the finger or the ear If clotted blood is available, the serum may be drawn up directly In this case, steps 2 through 4 below may be omitted (2) Allow several minutes for the blood to clot in the capillary tube Remove the clot by breaking off one end of the capillary with a sponge, then tease the clot out with the help of the sponge (3) Seal the opposite end of the capillary in the flame, with the fingers holding the capillary as near the flame as possible in order to protect the serum from coagulation (4) Centrifuge at 1000 r p m for three minutes to obtain clear serum (5) Mark a hollow ground slide "A cells" on the left side, "B cells" on the right side and the subject's name in the center (6) Expel one large drop of the patient's serum from the capillary on to the center of a clean cover slip Add one small drop of known A cell suspension to the same cover slip Mix gently Deftly invert the cover slip and place on the side of the hollow ground slide marked "A cells" Seal with paraffin (7) Repeat step 6 using "B cell" suspension (8) Allow to stand for three to five minutes, occasionally rolling or tilting the slide to insure thorough mixing Examine microscopically and re examine after incubation at 37° C for thirty minutes If there is initial agglutination of both A and B cells, the thirty minute incubation is necessary only as a final check and for the elimination of cold agglutinins (9) Readings are made as follows agglutination of A and B cells = Group O, agglutination of B cells and not of A cells = Group A, agglutination of A cells and not of B cells = Group B, agglutination of neither A cells nor B cells = Group AB

Fresh suspensions (not over twenty four hours old) of A and B cells are necessary for proof grouping and should be made daily Proof grouping which does not check the blood grouping is due either to (1) error in the original determination of blood agglutino

	Blood Grouping		Proof Grouping	
	A (sera) anti B	B (sera) anti A	A (cells)	B (cells)
Group O	no agg	no agg	agg	agg
Group A	no agg	agg	no agg	agg
Group B	agg	no agg	agg	no agg
Group AB	agg	agg	no agg	no agg

gens or (2) feeble agglutinogens in the A or B cell suspensions Check (1) by redetermining the blood group with the test tube technic and (2) by making a fresh A and B cell suspension

2 *Test Tube Technic* (1) Prepare the unknown serum as follows Obtain 5 to 10 cc of whole blood in a clean dry tube and allow to clot Centrifuge to separate the serum (2) Into a Kahn tube labeled "A cells," introduce one drop of saline, one drop of the unknown serum and one drop of known A cells Into another Kahn tube labeled "B cells," introduce one drop of saline, one drop of unknown serum and one drop of known B cells Proceed as in the previous test, but the final macroscopic reading must be checked microscopically because agglutinins in the unknown serum are frequently of a low titer

If the proof grouping by agglutinins does not correspond to the grouping by agglutinogens, the blood should not be used until the laboratory has checked the blood by incubation and special checking methods In general, grouping by the determination of agglutinins is less reliable than grouping by the determination of agglutinogens, if highly potent sera are used

CROSS-MATCHING TECHNICS

A Blood Cross matching Test by the Hanging Drop Method

1 Make a red blood cell suspension of two drops of the patient's blood in 2 0 cc of normal saline

2 Make a similar suspension of the donor's blood If bank blood is used, tease the cells out from the clot by gently rotating a wooden applicator around the clot four times Then stir the end of the applicator in 2 0 cc of normal saline

3 Fill three capillary tubes, by capillary attraction, two thirds full of patient's blood Repeat with donor's blood Avoid bubbles

4 Place the capillaries in properly labeled test tubes

5 Mark a hollow slide + on one side and − on the other Record the name of the patient and donor or bank blood number in the center

6 Remove the clot from the blood in the capillary tubes by breaking off one end of the capillary with a sponge and tease the clot out with the help of a gauze sponge

7 Seal the opposite end of the capillary in the flame, holding the capillary by the fingers as near the flame as possible in order to protect the serum from coagulation

8 Centrifuge to obtain clear serum, at 1000 r p m for three minutes

9 Place one large drop of the patient's serum in the center of a clean cover slip by expelling all of the serum in the capillary

10 Add one small drop or one loopful of the donor's cell suspension to the same cover slip Mix gently

11 Deftly invert the cover slip Place on the side of the hollow ground slide marked + Seal with paraffin

12 Repeat the preceding procedure using the donor's serum and the patient's red cell suspension Place on the side of the hollow ground slide marked −

13 Seal with paraffin

14 Examine the slide for agglutination If there is none, place the slide in the incubator at 37° C for thirty minutes

15 At the end of that time, remove the slide, rotate and reexamine for agglutination

16 If there is none on either side, the blood is compatible in the major and minor classification Major cross matching represents the patient's serum and the donor's cells Minor cross matching represents the donor's serum and patient's cells

When a patient is first grouped, four hanging drop preparations are set up the first representing the cross matching as described above, the second, the grouping of the patient's cells, the third, proof grouping of the patient's serum, and the fourth, the grouping of the bank blood

B Cross match Test by the Tube Method

(This is an excellent method but it requires venous blood and does not lend itself to checking by other observers because the preparation will not stand It is therefore not in routine use)

(1) Obtain 5 to 10 cc of whole blood in a clean dry tube and allow to clot (2) Centrifuge to obtain clear serum and separate serum from the clot (3) Into a Kahn tube marked "Major," place one drop of saline, one drop of the patient's serum and one drop of the donor's cells (4) Into a similar tube marked "Minor," place one drop of saline, one drop of the donor's serum and one drop of the patient's cells (5) Incubate both tubes at 37° C for one hour Centrifuge for one minute at 1000 r p m and read both tubes macroscopically and microscopically for clumping after agitation of the tube

C Cross match Test Using Suspension of Cells in Serum

Most laboratories use saline suspensions of the donor's and the recipient's cells for cross matching, either by the test tube method, or by one of a variety of slide test methods This method detects

incompatibilities in the ABO system, but usually misses incompatibilities involving Rh agglutinins and other important abnormal agglutinins in which hyperimmune (so called "blocking" or "incomplete") antibodies are present The latter do not produce agglutination in saline suspensions of red cells, but do produce agglutination in serum or albumin suspensions of red cells It, therefore, is advisable to cross match by the following technics

1 Suspend the cells of donor and recipient in their own serum (plasma is often unsatisfactory because of rouleaux formation) to a cell concentration of 2 to 4 per cent This is done with clotted blood by transferring cells from the clot with a wooden applicator stick to a small amount of the clear serum

2 Mix two drops of this cell suspension in serum with two drops of the appropriate serum (donor vs recipient or recipient vs donor) in a small test tube, such as a Kahn tube with measurements of approximately 7 by 70 mm

3 Place in a water bath at 37° C for fifteen minutes

4 Shake again, and spin at 1000 r p m for one minute

5 Read by *gently* tilting the tubes to separate the cell button from the bottom of the tube and looking for clumping of the cells

6 Negative or doubtful tests must be checked microscopically after transferring a small amount to a flat glass slide

Twenty per cent bovine albumin may be used instead of the serum for the cell suspension If the cross matching test was first done in small tubes using saline suspensions of cells, spin the cells down rapidly for a minute or two to pack them well, remove the supernatant saline as completely as possible, add two drops of 20 per cent bovine albumin, mix, allow to stand for ten or fifteen minutes at room temperature, spin for one minute at 1000 r p m and read as above This combined method detects both early immune and hyperimmune agglutinins

Emergency Situations

If withholding blood for the time required to perform a cross matching test may jeopardize the life of a patient, the cross matching may be omitted Group O blood neutralized with group specific substances may be used safely for transfusion in such a situation The Rh typing of the patient must be done even under emergency circumstances If there is no time for even this minimal procedure, then neutralized group O Rh negative blood may be utilized, if available

RH TYPING

All patients must be tested for Rh type so that reactions will be avoided from improper Rh bloods All Rh positive patients may safely receive Rh positive but not Rh negative blood Rh negative blood may contain a sensitizing factor known as HR, so that a second transfusion of such blood at a later date in an Rh positive patient may cause a reaction *Rh negative patients must receive only Rh negative bloods* The only exception is an emergency in which an Rh negative male who has never received blood requires blood and Rh negative blood is not available

The Rh type is determined by the slide or test tube method The slide method is applicable for rapid screening of recipients The tube method is particularly applicable to clotted blood It is also used to check an Rh negative finding by the slide method

In routine testing the Anti D (Anti Rho 85 per cent) serum should be used This will allow the separation of Rh negative from Rh positive bloods

Slide Method

To a large drop of blood (approximately 0 1 cc) on a clean glass slide add one smaller drop (about 0 05 cc) of hyperimmune Anti D (Anti Rho 85 per cent) serum and mix with a wooden applicator After two or three minutes of frequent rotating or tilting of the slide on the warmed surface of the viewing box, large clumps develop when the patient is Rh positive A homogeneous, faintly granular appearance at the end of this time is a negative result If this is negative, repeat the procedure using the tube method described below

Tube Method

(using early immune serum)

A 2 per cent suspension of red cells is prepared by adding two full drops of blood to 1 cc of saline Two drops of this suspension are placed in a Kahn tube Add a drop of saline and a drop of the 85 per cent early immune anti Rh serum *warmed to room temperature before use* Set up a duplicate test using 87 per cent early immune Anti D and Anti C serum to determine if the patient is negative or prime positive The test tube is placed in a 37° C water bath or incubator for one hour Then gently agitate and centrifuge at no more than 500 revolutions for one minute Tilt or rotate the tube gently six times to loosen the sediment at the bottom of the tube Include

control tests on one known Rh positive and one known negative blood as controls

Note This method is sensitive, but owing to rapid deterioration of the serum, errors are possible If the result is doubtful, the rapid tube method (see below) should be employed

Rapid Rh Tube Method
(using hyperimmune serum)

This serum requires the complete absence of saline as a suspension medium for red cells

Make a suspension from the clotted blood sample, using the serum of the sample itself so that a 2 to 4 per cent concentration is obtained Mix two drops of this suspension in a Kahn tube with one drop of the testing serum Allow to stand for fifteen minutes at room tempera ture or ten minutes in a 37° C water bath Centrifuge at 1000 revo lutions for one minute Agitate, read macroscopically and if negative, microscopically

Neutralization of Agglutinins in Group O Blood and Plasma

The titer of Anti A and Anti B agglutinins in at least 25 per cent of Group O bloods is so high as to render Group O bloods unsafe as universal donors Similarly, unpooled plasma or plasma from small pools may have a high agglutinin titer and cause hemolytic reac tions If Group O blood is to be used in Group A, B or AB patients or in emergencies before grouping and cross matching can be done, the blood is neutralized by adding 10 cc of group specific substances, i e, a solution containing the agglutinogens A and B The latter should be kept in vials along with prepared needles and syringes in the bank The group specific substances are put into the receiving flask and the filtered blood is then added The flask is then agitated and rotated for thorough mixing

Plasma pools are made up from three whole bloods (never more) to minimize the danger of transfusing the virus of homologous serum jaundice Such small pools, while generally low in Anti A and Anti B agglutinins, should be neutralized with group specific substances to reduce agglutinin titers Plasma is unsafe to use without group spe cific substances, except when the grouping of the plasma and the recipient's blood correspond Ultraviolet radiation of plasma may prove to be an effective method of destroying virus, if present

Transfusion Reactions

When a reaction to blood or plasma occurs, the flasks and their contents and 10 cc of the patient's blood are sent to the laboratory

for further cross matching tests, serum bilirubin and serum hemo globin determination A urine specimen is also sent for hemoglobin analysis In the case of a hemolytic reaction, further studies of renal function are required

1 *Pyrogenic* Chills and fever may occur during or after the transfusion If this is the case while blood or plasma is being infused, stop the infusion immediately

2 *Allergic* These usually take the form of an urticaria or asthmatic attack and appear after the transfusion is over Epi nephrine, ephedrine or anti histaminic substances may be used for treatment

3 *Hemolytic* This is the most uncommon type, but the most serious It is frequently fatal It is manifest, unless the patient is under anesthesia, by vomiting, headache, flank pain and chills, usu ally during the early phase of the transfusion and occasionally only after it is completed Hemoglobinemia and hemoglobinuria develop Mismatched or mislabeled blood is the usual cause, more often the latter A lower nephron nephrosis with rapid renal failure and death frequently follows

4 *Pulmonary edema* may result from an excessive infusion rate or an excessive volume of blood or plasma The average adult can safely receive a liter of fluid in thirty minutes, if desired

5 *Shock Therapy* When blood is urgently needed for shock therapy it may be infused as rapidly as the apparatus available can supply it *If the blood is forced in by air pressure, the vein must be shut off from the system before all the blood has left the flask Deaths from air embolism have resulted from failure to observe this precaution*

CHAPTER 41

CLINICAL PROCEDURES

Abdominal Paracentesis

This is performed (1) for the relief of distress due to ascites, (2) for study of the total protein and albumin globulin ratio, cell content, neoplastic or inflammatory cells, etc Put the patient in the sitting or semi reclining position Catheterize the patient to prevent insertion of the trochar into a distended bladder Sterilize enough skin area with tincture of zephiran so as to dispense with the need for draping Infiltrate with procaine about 2 inches below the umbilicus, first intracutaneously, then subcutaneously and finally down to the peritoneum Make a small incision through the skin with a knife blade With steady firm pressure and rotary motion insert a trochar with an attached rubber tube running to a collecting vessel Pull back the stylet If fluid flows freely, collect it in suitable vessels If fluid does not flow freely, try facing the trochar at a different angle Fluid is tested for (1) specific gravity, (2) cell count, (3) total protein, (4) smear and culture, (5) cell block For the latter, send the bulk of the fluid collected

Catheterization

(See chapters on Postoperative Care and on Urologic Disorders)

Circulation Time

This test is used to determine velocity of blood flow in a variety of conditions such as congestive heart failure, pulmonary disorders polycythemia vera, thyrotoxicosis If abnormal, repeated tests will show the effect of treatment

The patient is to be instructed adequately as to the nature of the test and the end point he is to experience

The following method is the one in routine use sodium dehydrocholate (Decholin) 20 per cent—3 0 to 5 0 cc The end point is a bitter taste in the tongue

Perform the venipuncture, using a 19 gauge needle Remove the tourniquet and inject the substance rapidly Record the beginning of the injection as the starting time Record the patient's first perception of the end point as the finishing time Perform two or three trials and record all values Normal values are 12 to 19 seconds *Precaution* Do not use more than 12 cc of dehydrocholate in a single patient

Record results *immediately* on the back of the laboratory sheet, noting agent, site of injection, time and sharpness of end point

SPECIMEN REPORT

Circulation time	Decholin—Arm to tongue
(1) 17 sec	
(2) 18 sec	good end points
(3) 17 sec	

Other tests may be used Calcium gluconate, 10 per cent—3 0 cc the end point is a warm sensation in the tongue Methylene blue this is an objective test The end point is a photoelectric recording of increase in optical density of the ear lobe

Gastric Analysis

(See chapter on Surgical Diseases of the Gastro intestinal Tract)

Gastric analysis is done for determination of acidity in peptic ulcer, carcinoma and pernicious anemia and the physiologic response of the chief cells to nervous or humoral stimulation A Levin tube, chilled and well lubricated, is inserted through the nose If necessary, shrink the nasal mucosa with cocaine or 1 per cent neosynephrin If gagging is excessive, swab the pharynx and fauces with ½ per cent pontocaine and wait ten minutes As the tube is pushed down, water is given and the patient is instructed to keep swallowing Remove the fasting gastric contents for study Test for free acid with congo red paper If negative for acid, have the nurse administer 1 mg of histamine hydrochloride subcutaneously and collect a final specimen for acid twenty minutes later

If fractional specimens are desired, 5 cc of alcohol diluted with 50 to 100 cc of water is injected through the tube and specimens withdrawn at twenty, forty and sixty minutes

In peptic ulcer, the response to insulin is determined, especially if vagotomy is planned A negative insulin response after vagotomy signifies the total absence of psychic secretion and therefore, complete section of both vagus nerves In this test, 5 to 10 units of insulin are injected and the test is repeated as for histamine

SPECIMEN REPORT

TIME	VOLUME	COLOR	FREE ACID	TOTAL ACID
1 Fasting	16 cc	clear	10	15
2 Twenty minutes	10 cc	clear	15	25
3 Forty minutes	12 cc	clear	20	30
4 Sixty minutes	8 cc	green	10	15
5 Histamine	15 cc	green	40	50
6 Insulin (after vagotomy)	—	—	00	00

In addition, note is made of the guaiac test, gross blood or other positive data from the microscopic examination, e g , acid fast organisms, red cells

Lumbar Puncture

(See chapter on Neurosurgical Disorders)

Lumbar puncture should be performed only for essential information in diagnosis or for treatment In the presence of increased intracranial pressure, the possible danger of producing an acute pressure cone requires that lumbar puncture be avoided or performed only after neurosurgical consultation

Position of the patient The patient's back should be in a line with the edge of the bed, with the intercristal plane perpendicular to the plane of the mattress, the knees flexed on the abdomen and the neck flexed

The usual site for inserting the needle is between the third and fourth lumbar spinous processes, just above line joining crests of ilia

Prepare a large area with tincture of zephiran It is not necessary to drape the field Put on gloves

Raise a wheal with procaine (1 per cent) over the site of puncture With a larger needle infiltrate deeply

Be sure that the stylet fits the needle Test the three way stop cock and manometer assembly Insert the needle in the midline and push directly forward with a quick thrust Increased resistance will indicate the area of the tough spinous ligaments A sudden "click" or cessation of resistance may be felt when the needle has entered the spinal canal

The fluid should flow freely when the stylet is removed Should it fail to do so, try rotating the needle 90 degrees, pushing it in a little farther (with stylet in place) or withdrawing slightly If fluid does not flow, remove the needle until it is just below the skin, redirect it and reinsert it

When the needle rests in the spinal canal, reassure the patient that all manipulation is over Allow him to relax for a few minutes before recording pressures

Attach the spinal manometer to the three way stopcock Record the initial pressure Compress the abdomen with the flat of hand and record the rise and fall in spinal fluid pressure Compress the jugular vein first on one side, then the other and finally bilaterally Use sufficient pressure to compress the vein, but not to compress the carotid artery Be sure the patient is relaxed and is not holding his breath Record the rise and fall in pressure The measurement of spinal fluid dynamics carries a certain hazard and should be performed with care

Collect the spinal fluid Ordinarily two tubes with 5 cc each of fluid will be sufficient for all tests

Fluid is studied for cell count (including differential), total protein, Pandy, chloride, sugar, culture, serology, gold sol

Record data *at once*

SPECIMEN REPORT

Lumbar puncture	Date 3/29/48	Patient relaxed
Needle entered L3-4 without trauma		
Initial pressure—120	Oscillation normal	
Left jugular pressure	Rapid rise to 300	
	Rapid fall to 120	
Right jugular pressure	Rapid rise to 300	
	Rapid fall to 120	
Abdominal pressure	Rise to	Fall to
10 cc crystal clear fluid removed	Cell count 4	
	Differential rbc—1	
	Lymphocytes 3	
Final pressure 90		
Total protein		
Gold sol		
Kahn		

In surgery, lumbar puncture is often needed to induce spinal anesthesia The introduction of anesthetics is discussed in the chapter on Anesthesia

For *headache* following lumbar puncture keep the patient prone and use intravenous caffeine sodium benzoate If headache is persistent, the subarachnoid instillation of normal saline solution may relieve the headache (See tables in chapter on Special and Specific Medication)

Lumbar Sympathetic Block

(See chapter on Peripheral Vascular Disease)

Miller Abbott Tube

This tube and variations of it, such as the single lumen Harris tube, are passed precisely as is the Levin tube Check patency of the tube before passing it It serves no better purpose than a Levin tube unless it is maneuvered through the pylorus The use of 3 cc of metallic

mercury in the rubber balloon facilitates spontaneous passage as a rule, if the patient is kept on his right side and given sips of water frequently, advancing the tube 1 or 2 inches every hour When aspiration yields duodenal contents, the tube is probably in the duodenum It is frequently, if not usually, necessary to check the tube's progress by fluoroscopy The radiologist may succeed in pushing it through the pylorus when blind effort fails Once the tube has passed the pylorus, it is fed some 2 or 3 inches every half hour The balloon is not inflated with air unless special studies of intestinal contents are needed

The tube is frequently left in for many days It is a grossly uncomfortable experience for the patient and should be removed as soon as it is safe to do so Special lozenges are available to relieve the patient's throat discomfort

It should be remembered that while constant suction will effectively empty the gut of retained secretions, it is possible that once such retention is relieved, the continued aspiration of normal intestinal fluids is undesirable and may rapidly deplete the patient Keep a close watch on fluid and electrolyte balance in all intubated patients

Peritoneal Aspiration

In certain cases of doubtful diagnosis, a blunt tipped needle introduced into the free peritoneal cavity will often recover enough fluid, even if only a drop, to permit a microscopic study Determine the presence and type of inflammatory reaction (peritonitis, infectious mononucleosis, bleeding, fat droplets, etc) There is usually little or no risk of injury to viscera Liver and spleen biopsies may also be obtained, but this procedure may be followed by hemorrhage

Peritoneoscopy

This method of diagnosis is occasionally useful It has definite limitations (1) injury to the omentum and occasionally to other organs, with resulting severe bleeding, especially when peritoneal adhesions exist, (2) restricted field, it is not possible to see structures beneath the omentum Only structures lying adjacent to the anterior peritoneal wall can be seen, such as the lower aspect of the liver, gall bladder, peritoneal implants of carcinoma, fat necrosis, hemoperitoneum and peritoneal inflammatory reaction

Plaster

(See Fractures)

Pneumothorax

This procedure is performed generally as for thoracentesis, except that nothing is aspirated and air is introduced The apparatus used for the introduction of the air is a simple arrangement for the dis placement of air by water The air is injected through a large bore needle introduced at the preferred intercostal site in the usual way (see Thoracentesis) Although the procedure is usually performed in out patient tuberculosis clinics, there is occasional use of the method for diagnostic radiology of lung and mediastinal disorders

Sigmoidoscopy

(See chapter on Surgical Disease of the Gastro intestinal Tract)

Preparation of Patient A small enema consisting of not more than *one quart* of warm saline solution is administered to the pa tient three hours before the scheduled time of examination In cases of diarrhea the saline enema is given two hours before the examina tion Soap suds enemas should not be used to prepare the patient for sigmoidoscopy

The Instrument Before getting the patient into position al ways check the component parts of the sigmoidoscope to be sure they are all present and fit properly Never use force in assembling the instrument Check the light to be sure the bulb works The check of the instrument should not be done in the presence of the patient, who may be apprehensive concerning the examination At least twelve single ended cotton swabs should be ready, no larger than a grape, securely rolled around long applicator sticks

Position of the Patient Do not get the patient up into posi tion until certain that the sigmoidoscope is in working condition The patient should be in the *knee-chest* position, hips high, thighs vertical, knees wide apart chest on the examining table so that the back forms a concave curve The weight should not be on the head or on the elbows One arm may be tucked under the patient's abdomen and the head turned to one side for greater comfort If the examina tion is to be done in bed, a plywood board should be inserted between mattress and spring and the patient placed crosswise on the bed with knees on the edge of one side and the head on the other edge

Technic of Examination Prior to introducing the sigmoido scope, always perform a digital rectal examination to dilate the sphincter and insure that the lower rectum is not strictured or ob structed Have the patient strain or take a deep breath as the sig moidoscope is introduced As soon as the internal sphincter is passed, remove the obturator, turn on the light to proper but not excessive

intensity and introduce the instrument as far as possible under *direct vision* Progressive insertion should be made only while the lumen ahead can be seen *Never push blindly* All movements with the sigmoidoscope should be gradual, gentle and in a slight spiral curve A note should be made of any pathologic condition discovered as the instrument is introduced The more detailed phase of the examination should be made while the instrument is being gradually withdrawn During the examination the patient should be distracted by quiet, reassuring and encouraging conversation

Precautions The patient should be instructed to breathe gently and to avoid straining and sudden movements Never force the instrument against resistance When the lumen appears narrowed by spasm, wait a few moments, until the bowel relaxes, before introducing the instrument farther Do not use the air inflation rubber bulb, in the hands of the skilled it is unnecessary and in the hands of the untrained it may be dangerous In any event, inflation of the colon with air causes great discomfort to the patient and increases the tendency to spasm Air inflation will rarely bring the lumen into view Do not take a biopsy unless the examination is being performed in the operating room and facilities are at hand for immediate control of unexpected hemorrhage by fulguration, packing or other measures At the conclusion of the examination do not permit the patient to raise his head suddenly Have him sink into the prone position and lie there a few minutes before sitting up

Sternal Aspiration

The patient lies flat in bed and the area is prepared with tincture of zephiran Drape with a baby lap sheet or none if the sterilized area is large enough

Locate the area of the sternum just below the junction of the manubrium and the body Palpate both sides of the sternum to locate the midline Infiltrate the skin and then the subcutaneous tissue with procaine and then inject procaine straight down into the periosteum, which is identified by the spongy sensation that is transmitted to the needle as it is penetrated

The sternal needle is inserted at the anesthetized site With the left hand as a brace to control the rate of motion, the needle is pushed in slowly with a direct thrust or a rotary motion *Be sure it is in the midline*

When you have penetrated the outer plate of the sternum, withdraw the stylet and attach a dry 10 cc syringe Suction will cause

Pneumothorax

This procedure is performed generally as for thoracentesis, except that nothing is aspirated and air is introduced The apparatus used for the introduction of the air is a simple arrangement for the dis placement of air by water The air is injected through a large bore needle introduced at the preferred intercostal site in the usual way (see Thoracentesis) Although the procedure is usually performed in out patient tuberculosis clinics, there is occasional use of the method for diagnostic radiology of lung and mediastinal disorders

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(1) specific gravity, (2) cell count and differential, (3) protein content, (4) cell block, (5) organisms by smear or culture "Guinea pig" the fluid if tuberculosis is suspected If tumor of the lung is suspected, as much fluid as possible is to be left with the pathology laboratory for cell block

SAMPLE REPORT

Thoracentesis Left side of chest Needle inserted in posterior axillary line two interspaces below angle of scapula
1100 cc. straw-colored hazy fluid withdrawn
Specific gravity 1 018
Cells before hemolysis
Cells after hemolysis
Differential count
Gram and Ziehl Neelsen stains
Culture (if tuberculosis is suspected request tuberculosis culture specifically)

Thoracentesis is performed for diagnosis or treatment Carcinoma, hemorrhage, inflammation or transudation will be revealed by examination of the fluid Cardiorespiratory embarrassment can result from aspiration of too much fluid in large fluid accumulations The introduction of antibiotics (penicillin) after aspiration of pleural exudate constitutes a nonsurgical method of treatment of pyogenic empyema in selected cases

The entrance of air should be avoided except when required for compression of the lung "Pleural shock" is probably a type of vascular collapse that may be due to air embolism via a pleural or intercostal vein

Venous Pressure

Equipment reservoir for saline, glass tubing with a centimeter rule for calibration, pinch clamp, sterile rubber tubing, No 18 needle, 1 per cent procaine with needle and syringe carpenter's level, flask of sterile saline

The patient should be supine However, the head of the bed may be raised to a comfortable level to relieve dyspnea The patient should be comfortable, relaxed, calm The arm should be abducted about 20 to 30 degrees laterally from the body

Infiltrate the skin over a large antecubital vein with procaine Fill the entire system (reservoir, rubber tubing and glass tube) with saline and wash it through thoroughly to eliminate air bubbles Fill the glass tube with saline and clamp off the reservoir

Introduce the No 18 needle through the anesthetized skin well into the vein Allow the saline in the glass tube to reach a constant level and read Release the pinchcock leading to the reservoir wash out the glass tube take two more readings

slight pain Withdraw a small amount of marrow and spread it on slides After completing this, withdraw about 4 cc of bloody fluid and allow it to clot in the syringe Remove the clot without breaking it up

Send the slides and the clotted marrow to the laboratory

Thoracentesis

Perform an examination of the chest to outline the level of pleural fluid Consult the x ray film Have an assistant (nurse or medical student) present

Place the patient in the proper position i e, sitting up and leaning forward with the arms crossed in front, which is the position giving the widest interspaces The patient may well be seated on the side of the bed with the feet resting on a stool or chair In the event that the patient is extremely weak or dyspneic, he should be supported by the assistant In any case he should be relaxed, comfortable and reassured, so that the procedure will be accomplished with the minimal mental or physical trauma If the patient is apprehensive, it is well to give 10 to 15 mg of morphine before the procedure

Sterilize the skin with tincture of zephiran Put on sterile rubber gloves Sterile towels are cumbersome, do not stay put and are not necessary if the area of sterilization is generous

Palpate the interspaces to determine the best site The needle is usually inserted in the seventh or eighth interspace between the posterior midline and the posterior axillary line In every case it should be inserted just above the rib, rather than below it, to avoid trauma to the intercostal vessels Infiltrate the skin with procaine, using a No 25 needle and then infiltrate the subcutaneous structures and pleura, using a larger needle

The apparatus used consists of a large bore (No 16) short bevel needle attached by a three way stopcock to a 30 or 50 cc syringe and to rubber tubing leading to a collecting vessel Assemble the apparatus and test the stopcock Insert the needle through the anesthetized area until it is felt to penetrate the pleura Pull back on the syringe Discharge the fluid into a collecting vessel

It is desirable to limit the amount of fluid withdrawn at one tap to 1000 to 1500 cc If the patient begins to complain of shoulder or chest pain, it is well to shift the position of the needle or to stop the tap After completing the tap, paint the puncture wound with tincture of benzoin

A record should be made in the progress notes, at once, of the amount and type of fluid withdrawn Fluid may be examined for

Technic Obtain (1) a sterile vial containing citrate solution from the bacteriology laboratory, (2) an autoclave sterilized 20 to 30 cc syringe and needles Sterilization by boiling or by chemicals is not satisfactory Remove the string tying the cloth to the vial, loosen the cover, but leave it in place Obtain 15 cc of blood, lift off the cover and inject without flaming through the rubber cap into the vial Mix by gentle shaking Fill out a slip *Send the vial and the slip to the laboratory immediately*

In the laboratory the blood will be partitioned, 10 cc to a flask of tryptic digest broth, 3 cc to a tube of thioglycollate broth, 2 cc to a tryp agar pour plate All will be initially inoculated under carbon dioxide

The practice of allowing blood to remain in an icebox overnight until the arrival of the technical staff is unsatisfactory

Certain more fastidious organisms, e g , Brucella, Streptobacilli, etc , may require specialized technic When an unusual organism is suspected, the laboratory should be consulted

(2) *Exudates, Pus, etc* Wash away the superficial material by irrigation Obtain the material on a sterile swab moistened with broth or by syringe aspiration from the depths of the wound Drop the swab into a tube containing 1 or 2 cc of sterile broth and transmit to the laboratory immediately Desiccation of the ordinary swab in transmission often makes it useless

At the same time a smear from another swab should be made on a glass slide for a gram stain In the case of abscess a few cc of pus should be placed in a sterile tube and dispatched to the laboratory

(3) *Throat Cultures* The broth swab technic as in (2) above should be used Culture for diphtheria bacillus, meningococcus, influenza bacillus, pneumococcus, etc , must be specifically requested

(4) *Spinal Fluid* Allow a few drops to fall on a warmed (room temperature) chocolate or blood agar slant Place 5 cc of the fluid in a sterile tube and transmit slant and tube to the laboratory It is important to avoid chilling meningococci In the laboratory the fluid is centrifuged A gram stained smear is made of the sediment, which is also inoculated upon starch agar and chocolate or blood agar Incubation is under carbon dioxide

(5) *Stool Culture* The recovery of pathogens from stools depends upon repeated culture of fresh specimens The most satisfactory technic is to streak an SS plate heavily and an EMB plate lightly with a swab freshly loaded through a proctoscope or from a fresh stool emulsion Two cc of stool emulsion are inoculated into a tube of tetrathionate broth

CHAPTER 42

LABORATORY PROCEDURES

Processing of Ascitic, Joint, Pleural and Spinal Fluids

These fluids should be collected as follows (1) The time of the aspiration should be recorded on each specimen container as well as on the patient's record This is important to assure proper cor relation of the tests (2) Secure the fluid in three separate test tubes The first tube should be sterile and should contain 6 0 cc if serology, gold sol and culture are desired The second tube should contain 1 0 cc for cell count and globulin tests If, in addition, specific gravity is desired, add 10 0 cc to an oxalate bottle and rotate twenty times to prevent coagulation The third tube should contain 3 to 5 cc for chemical determination, such as total protein, chlorides, sugar and mucin

Whenever possible, the total cell count should be made immedi ately after the collection of fluid, while the cells are in suspension and before coagula have formed If there is no excessive fibrinogen so that coagulation does not occur, counts made some hours later or the next day are fairly accurate if the fluid is well shaken Fluid collected in a tube containing a minute amount of potassium oxa late may stand for several hours and still yield accurate counts

Bacteriology

This section contains a brief critical compilation of available bacteriologic and serologic diagnostic procedures Their efficiency, in particular of the cultural methods, depends largely on the care in obtaining the specimen and promptness in conveying it to the labo ratory

(1) *Blood Culture* This should be used freely and in the in dividual case repeatedly It is an important diagnostic method and consequently of therapeutic importance Blood culture should be taken prior to the institution of therapy Intravenous medication of any kind should be avoided for several hours prior to blood cul ture Even glucose solution intravenously may cause a temporary nonspecific suppression of bacterial growth in an existing bacteremia

Technic Obtain (1) a sterile vial containing citrate solution from the bacteriology laboratory, (2) an autoclave sterilized 20 to 30 cc syringe and needles Sterilization by boiling or by chemicals is not satisfactory Remove the string tying the cloth to the vial, loosen the cover, but leave it in place Obtain 15 cc of blood, lift off the cover and inject without flaming through the rubber cap into the vial Mix by gentle shaking Fill out a slip *Send the vial and the slip to the laboratory immediately*

In the laboratory the blood will be partitioned, 10 cc to a flask of tryptic digest broth, 3 cc to a tube of thioglycollate broth, 2 cc to a tryp agar pour plate All will be initially inoculated under carbon dioxide

The practice of allowing blood to remain in an icebox overnight until the arrival of the technical staff is unsatisfactory

Certain more fastidious organisms, e g , Brucella, Streptobacilli, etc , may require specialized technic When an unusual organism is suspected, the laboratory should be consulted

(2) *Exudates, Pus, etc* Wash away the superficial material by irrigation Obtain the material on a sterile swab moistened with broth or by syringe aspiration from the depths of the wound Drop the swab into a tube containing 1 or 2 cc of sterile broth and transmit to the laboratory immediately Desiccation of the ordinary swab in transmission often makes it useless

At the same time a smear from another swab should be made on a glass slide for a gram stain In the case of abscess a few cc of pus should be placed in a sterile tube and dispatched to the laboratory

(3) *Throat Cultures* The broth swab technic as in (2) above should be used Culture for diphtheria bacillus, meningococcus, influenza bacillus, pneumococcus etc must be specifically requested

(4) *Spinal Fluid* Allow a few drops to fall on a warmed (room temperature) chocolate or blood agar slant Place 5 cc of the fluid in a sterile tube and transmit slant and tube to the laboratory It is important to avoid chilling meningococci In the laboratory the fluid is centrifuged A gram stained smear is made of the sediment, which is also inoculated upon starch agar and chocolate or blood agar Incubation is under carbon dioxide

(5) *Stool Culture* The recovery of pathogens from stools depends upon repeated culture of fresh specimens The most satisfactory technic is to streak an SS plate heavily and an EMB plate lightly with a swab freshly loaded through a proctoscope or from a fresh stool emulsion Two cc of stool emulsion are inoculated into a tube of tetrathionate broth

(6) *Pleural and Peritoneal Fluid* Submit a generous sample If the fluid clots early, it is wise to use the blood culture citrate bottle as a container If tuberculosis is suspected, request a culture, a procedure which is reasonably sensitive with modern technics The centrifuged sediment is gram stained, streaked on a blood plate and an EMB plate and inoculated into thioglycollate broth

(7) *Sputum* Sputum should be collected after the mouth has been rinsed with water The specimen should not contain saliva or nasal secretion If none is available, the patient may be asked to cough and the sputum is swabbed off the posterior pharynx In the infant, a swab may be taken from the larynx via a laryngoscope The normally mixed flora in sputum make the bacteriologic diagnosis difficult The culture is of diagnostic value when it shows predominantly a single pathogenic organism such as the hemolytic Streptococcus, Staphyloccocus, Friedlander's bacillus, etc Pathogenic pneumococci are best demonstrated by the Neufeld technic

(8) *Urine Culture* The common sources of error in urine cultures are contamination in obtaining the specimen and delay in transmission to the laboratory A voided urine in the male (after preliminary cleansing of the glans and discarding the first few cc) and a catheter specimen in the female are satisfactory The urine is streaked on an EMB plate a blood plate and inoculated into broth

Urine culture is one of the better ways to detect latent or chronic gonorrhea in the male The first 50 cc of urine is collected as usual or, alternately, after prostatic massage The urine is centrifuged and the sediment streaked on a starch agar plate for incubation under carbon dioxide

Serologic Methods

Agglutination Tests The demonstration of a definitely rising titer during an illness is usually diagnostic, therefore, the first specimen of blood should be taken as early as possible in the illness The peak of the rise will usually be the tenth or fourteenth day It is often desirable to send a blood specimen marked simply "Hold" The serum can be saved and subsequently, when the possibilities become more sharply defined, a second serum specimen may be taken and tests ordered

Following is a list of recommended agglutination tests The limitations of each must be known for correct interpretation (1) Widal Paratyphoid A and B and Typhoid (2) Weil Felix or Proteus OX 19 —*Rickettsia* (3) Undulant fever—*Brucella abortus*, (4) Tularemia—*Pasteurella tularensis*, (5) Weil's disease—*Leptospira*

icterohemorrhagica, (6) Sheep cell agglutinins—Infectious mononucleosis, (7) Cold agglutinins for human red cells—Viral pneumonia

Precipitation Tests (1) Hinton test 5 cc of clotted blood or 5 cc of spinal fluid, (2) Kahn test 5 cc of clotted blood or 5 cc of spinal fluid, (3) Streptococcal grouping for the differentiation of Group A human hemolytic streptococci from those of animal or fecal origin

Skin Tests The following tests are of some diagnostic value

SKIN TESTS

MATERIAL	TIME READ	SIZE OF POSITIVE	INTERPRETATION
Tuberculin	48 hrs	Edema and erythema more than 5 mm	Previous or current infection
Brucellergen or *Br abortus* vaccine	48 hrs	Edema and erythema more than 5 mm	Previous or current infection
Chancroid vaccine	48 hrs	Edema greater than 8 mm and erythema greater than 14 mm	Previous or current infection
Detoxified killed *Past tularensis*	48 hrs	Edema and erythema greater than 10 mm	Previous or current infection
Diphtheria toxin Schick test	48 hrs and 96 hrs	Edema and erythema greater than 10 mm	Susceptibility
Erythrogenic streptococcal toxin Dick test	24 hrs	Erythema greater than 10 mm	Susceptibility
Lymphogranuloma virus (inactivated) Frei test	48 hrs	Induration of 5 to 6 mm	Previous or current infection
Mumps virus (inactivated)	24 hrs 48 hrs	Erythema greater than 10 mm	Previous infection Immunity
Trichina larvae extract	15 min and 24 hrs	Wheal 3 mm or more Erythema and induration	Previous or current infection
Coccidioides immitis extract	48 hrs	Edema and erythema	Previous or current infection

Capsular Swelling Tests (1) PNEUMOCOCCAL TYPING This is the procedure of election in identifying pneumococci in any exudate—sputum spinal fluid or pleural fluid (a) With a loop pick out some purulent or bloody sputum and emulsify it in a few drops of saline solution in a sterile Petri dish (b) Put a loopful of the emulsion on each of six cover slips, add two large loopfuls of each of the six pools of typing sera, vials A to F Add a loopful of methylene blue and stir

with the end of an applicator (Note Flame the loop and allow to cool each time before entering the serum vials, in order to avoid mixture of sera) (c) Ring the depressions in the slides with petro latum, label each A, B or C, etc , and place the corresponding cover slips over the hollows of the slides (d) Incubate at 37° C for twenty to thirty minutes and examine under oil A positive result shows a stained diplococcus surrounded by a sharply defined swollen ground glass type of capsule (e) Repeat with individual sera of the positive group (f) If quellung does not occur, but pneumococci appear to be numerous or if agglutinated clumps are seen, dilute the sputum fur ther and repeat the test using more serum (g) If quellung is not de monstrable, typing may be performed by intraperitoneal inoculation of 0 5 cc of sputum emulsion into a mouse The mouse is to be left for autopsy by the technical staff (h) Gram stain of sputum and inoculation upon a blood plate should always be performed

(2) HEMOPHILUS INFLUENZAE TYPING *Hemophilus influenzae*, Type B (Pfeiffer's bacillus), may be identified directly from the spinal fluid by type specific quellung with specific anti serum The progress of serotherapy should be followed by noting the appearance of quell ung by the patient's serum against his infecting organism

(3) FRIEDLANDER'S BACILLUS This may be identified by quell ung against antisera types A, B and C

Miscellaneous PENICILLIN SUSCEPTIBILITY OF CULTURED ORGANISMS This is to be performed by determining the organism's ability to grow in serially increased amounts of penicillin

PENICILLIN LEVEL OF SERUM The penicillin level of serum and other body fluids is determined by comparing the ability of serial dilutions of the test serum to inhibit a streptococcus of known sensitivity Ten cc of sterile clotted blood is required The dos age of penicillin and the time of obtaining the specimen should be recorded

COAGULASE TEST Virulent staphylococci are in general able to coagulate human plasma Mannitol fermentation has a similar but less reliable significance

VIRUS INFECTIONS Diagnostic procedures should be arranged for individually by consulting with the laboratory

Stained Smears Make a thin smear, dry in air and fix by pass ing the slide three times through a Bunsen flame

GRAM STAIN (1) Stain one minute with gentian violet, (2) wash in water, (3) flood with Gram's iodine for one minute, (4) wash in water, (5) decolorize with acetone for about thirty seconds or until violet dye fails to appear in the acetone (6) wash in water (7)

counterstain for ten seconds with three drops of dilute carbolfuchsin or with safranine, (8) wash in water Dry with compressed air jet

ZIEHL NEELSEN STAIN (1) Flood the fixed smear with carbol fuchsin and let stain for twenty minutes at room temperature, (2) wash with acid alcohol until no more red dye comes away and then continue washing for another thirty seconds, (3) wash in water, (4) counterstain in methylene blue for ten to thirty seconds, or with picric acid for two to three minutes, (5) wash in water and dry in compressed air jet, (6) acid fast organisms appear as red rods against a blue or yellow background

CHAPTER 43

CLINICAL CHEMISTRY

BLOOD TESTS

The table on p 407 lists the chemical determinations commonly done on blood and indicates the type of container and the minimum quantity of blood, serum or plasma that should be provided If several determinations are to be done on the same blood, a smaller amount per test will usually suffice This amount is indicated below under the heading of "Usual Blood Combinations" Many tests are spoiled when specimens are delivered in improper containers or with inadequate quantities of blood Consult the tables whenever a test is to be done

USUAL BLOOD COMBINATIONS

	CONTAINER	MINIMUM QUANTITY REQUIRED
Calcium and Phosphate or Calcium Phosphate TP	Tube	12–15 cc
Cholesterol and Cholesterol Esters	Tube	8 cc
Blood Sugar and NPN	Oxal	3 cc
Blood Sugar and CO_2	Oxal	8 cc
NPN and Sulfonamides	Oxal	5 cc
NPN Blood Sugar and Sulfonamides	Oxal	5 cc
NPN Blood Sugar Sulfonamides and CO_2	Oxal	10 cc
TP Albumin/Globulin and NPN	Tube and Oxal	6 cc in tube—3 cc in Oxal

Blood Calcium

The calcium of the blood is found entirely in the plasma or serum Red cells contain no calcium Half of the total serum calcium is bound to protein The remainder is dialyzable and in the ionic form Hyper or hypocalcemia should be determined in terms of a normal total protein level A blood calcium of 12 mg per 100 cc with a high total protein is not necessarily a hypercalcemia The blood calcium is decreased in hypoparathyroidism and in nephritis and in some cases of acute pancreatitis It is increased in hyperparathyroidism and in patients who have received excessive amounts of vitamin D

CHEMISTRY LABORATORY TESTS

DETERMINATION	MATERIAL ANALYZED	CONTAINER	MINIMUM QUANTITY REQUIRED	NORMAL VALUES
Albumin/Globulin	Serum	Tube	8 cc	3 8–5 5/1 5–3 5 gm /100 cc
Amylase	Serum	Tube	8 cc	40–100 mg /100 cc
Bilirubin	Serum	Tube	5 cc	0 08–0 82 mg /100 cc
Bromide	Serum	Tube	15 cc	Variable
Bromsulfalein 5 mg /kg i v State body wt	Serum	Tube	2 Spec – 10 cc 45 Spec – 10 cc	45 –less than 5% retention
Calcium	Serum	Tube	8 cc	9–11—mg /100 cc
Cephalin Flocculation	Serum	Tube	3 cc	Not over 2+
Cholesterol	Serum	Tube	8 cc	170–250 mg /100 cc
Cholesterol Esters	Serum	Tube	8 cc	75% of total cholesterol
CO Combining Power	Plasma	Oxal	5 cc	55–75 vols %
Congo red 0 25 cc of 1 5% aqueous solution/kg body wt i v Use no more than 18 cc	Plasma	Oxal	4 Spec – 10 cc 1 Spec – 10 cc	More than 60% retention after 1
Creatine	Whole Blood	Oxal	5 cc	5–6 mg /100 cc
Creatinine	Whole Blood	Oxal	3 cc	1–2 mg /100 cc
Glucose (macro)	Whole Blood	Oxal	3 cc	80–120 mg /100 cc
Icterus index	Serum	Tube	5 cc	Under 8 units
NPN	Whole Blood	Oxal	3 cc	20–35 mg /100 cc
Phosphatase (acid)	Serum	Tube	8 cc	0 5–2 units (Gutman)
Phosphatase (alkaline)	Serum	Tube	15 cc	2–4 units (Bodansky)
Phosphate Inorganic	Serum	Tube	8 cc	2 5–4 5 mg /100 cc
Protein Total (TP)	Serum or Plasma	Tube or Oxal	3 cc	6 5–8 2 gm /100 cc
Prothrombin Time	Whole Blood	Special Tube	4 5 cc	Same as control
Sed Rate	Whole Blood	Special Tube	5 cc	Not over 0 5 mm /min
Sodium	Serum	Tube	15 cc	135–150 mEq /liter
Sodium Chloride	Serum	Tube	5 cc	570–620 mg /100 cc
Sulf Levels	Whole Blood	Oxal	3 cc	Variable
Thiocyanate	Serum or Plasma	Tube or Oxal	20 cc	Variable
Thymol Turbidity	Serum	Tube	3 cc	0–6 units
Urea Nitrogen	Whole Blood	Oxal	3 cc	14–18 mg /100 cc
Uric Acid	Serum	Tube	6 cc	6 mg /100 cc or under
Van den Bergh (Direct Indirect)	Serum	Tube	8 cc	Negative

Blood Chlorides

Plasma or serum normally contains from 570 to 620 mg per 100 cc expressed as sodium chloride or 103 milli equivalents of chloride

per liter Decreased chlorides occur in vomiting or diarrhea and in Addison's disease Abnormal blood chloride values do not signify a serious disorder Abnormal sodium chloride values are of clinical importance because it is the sodium ion, not the chloride ion, which governs the fluid and electrolyte balance

Blood Cholesterol

Blood cholesterol is increased in diabetes, nephritis, nephrosis, biliary obstruction and myxedema This test is of particular value in hypothyroidism, in which a normal blood cholesterol is rarely found Serum or plasma is preferred to whole blood for analysis, since pathologic variations in the distribution between free and ester forms occur largely in the serum or plasma Cholesterol esters represent 75 per cent of the total cholesterol, the remaining 25 per cent represent free cholesterol In liver damage the percentage of esters may be decreased

Blood Nonprotein Nitrogen

Nonprotein nitrogen in the blood includes that derived from urea, uric acid, creatinine, creatine, amino acids, glutathione and a small amount of undefined nitrogenous substances Urea nitrogen represents about 45 per cent of the total nitrogen Ordinarily the nonprotein nitrogen is a simpler and probably more reliable test for the determination of nitrogen retention than urea nitrogen The urea fraction, which usually rises in kidney diseases, may be decreased in severe liver diseases *Creatinine* is the most stable nitrogenous constituent of the blood and is significantly elevated in nephritis The determination of blood creatine has little clinical value *Uric acid* is increased in nephritis, gout and leukemia

Blood Phosphate

The normal inorganic phosphate content of blood serum is about 3 7 mg It is increased in nephritis and hypoparathyroidism It is decreased in hyperparathyroidism, and is of diagnostic significance in this disease if the value falls below 3 mg per 100 cc

Blood Sugar

The normal fasting blood sugar is from 80 to 120 mg per 100 cc Borderline values strongly suggesting the presence of diabetes vary from 120 to 140 mg Values above 140 mg are unequivocably diagnostic of diabetes Normal or borderline fasting values will frequently be encountered in mild or controlled diabetes so that values in this

range do not exclude diabetes In patients suspected of diabetes because of a history of glycosuria or the presence of glycosuria with a green reduction of Benedict's solution in a single urine specimen, one should proceed as follows Place the patient on a diet containing large amounts of rapidly assimilable carbohydrates, such as fruit juice, sugar, cereal foods After the patient is on this diet, test urine specimens for two days, before each meal and at bedtime, for reducing substances with Benedict's solution If all specimens are aglycosuric, no further investigation is necessary If glycosuria is present, further study is made in accordance with the color of the reduced Benedict's solution as follows I Patients with a single or repeated green reduction should have a blood and urine glucose determination two hours after a test dose of 100 grams of glucose in 20 per cent solution given orally If the values obtained are normal, diabetes is excluded and no further studies are required II Patients who show an olive through red reduction of urine should have a fasting blood sugar determination If this value is 140 mg or higher, the diagnosis of diabetes is established III Doubtful or borderline results in either I or II should be investigated by the performance of a glucose tolerance test Hypoglycemia occurs principally in islet cell tumors, in Addison's disease and following excessive doses of insulin

Serum Phosphatase

Normal serum contains enzymes which catalyze the liberation of inorganic phosphate from phosphate esters, such as glycerol phosphate The most active phosphatase is known as alkaline phosphatase, because it is most active at a *p*H of 9 Acid phosphatase is of limited activity in normal serum but at a *p*H of 5 it is very active The latter is essentially of value only in carcinoma of the prostate, when it is significantly increased The alkaline phosphatase is increased in Paget's disease, rickets and hyperparathyroidism, i e , in conditions in which there is rapid bone growth or bone repair It may also be increased in malignant disease of bone, in which calcification is occurring and in metastases of neoplasm to bone The alkaline phosphatase may be increased when the excretory function of the liver is disturbed, i e , in obstructive jaundice

Total Protein, Albumin and Globulin

A decrease of the total protein below 5 gm per 100 cc is likely to be accompanied by edema Increased total protein levels are found in Addison's disease, nephrosis multiple myeloma and cirrhosis of the liver Fractionation of the total protein into its albumin

and globulin fractions is indicated in the study of these disorders Decreased protein is found when there has been plasma loss by extravasation or albuminuria or when there is impairment of protein synthesis due to malnutrition, defective absorption or liver disease Fractionation of the albumin and globulin takes considerably more time and effort than the determination of total protein and should only be ordered when the information it provides is definitely required

Glucose Tolerance Test

The glucose tolerance test is best performed on patients who have been eating a relatively normal diet for several days preceding the test, as low carbohydrate diets and undernutrition may give tolerance curves of a diabetic type

On the day of the test breakfast is omitted A fasting blood sugar and urine are obtained and the patient is given 100 grams of U S P dextrose plus the juice of one lemon made up to a total volume of 500 cc This test meal should be served ice cold to reduce nausea At one, two and three hours after the ingestion of the meal, blood and urine for glucose determination should be secured and sent to the laboratory for analysis The half hour specimen is ordinarily not needed and the specimens after the third hour are only indicated when there is a question of hyperinsulinism

The glucose tolerance test is of greatest value in the diagnosis of diabetes The curve obtained in hyperthyroidism has a characteristic form and the test may, therefore, be indicated in that disease

KIDNEY FUNCTION TESTS

Four types of kidney function tests are available (1) those that determine concentrating power of the kidney, (2) those testing the excretion of dyes, (3) those testing the removal of nitrogenous substances from the blood, so called clearance tests, and (4) those determining various constituents of the blood, such as the nonprotein and urea nitrogen Concentration tests detect early renal impairment, dye and clearance tests are helpful in following impairment of kidney function, and nitrogen retention tests are helpful in advanced stages of kidney diseases and may indicate changes when all other tests already show maximal impairment It should be emphasized that no test will replace careful examination of freshly voided urine

The Mosenthal Test

When the kidney is normal, the urine at different periods of the day varies greatly in volume and specific gravity This shows the ready response of the kidney to the varying demands for elimination of water and solids The diseased kidney loses this adaptive power to a greater or less degree and the urine excreted consequently shows an almost uniform concentration from hour to hour

1 On the day before the test and the day of the test, give the patient a full diet Add 1 pint of fluid at each meal on the test day No food or liquid is to be taken between meals Have the patient empty the bladder immediately before breakfast on the day of the test and discard this urine Collect urine at 10 A M , 12 noon, 2, 4, 6 and 8 P M and finally at 8 A M the next morning The intervals must be exact The last two hour specimen must be collected not less than three hours after the evening meal In other words, dinner should be eaten at about 5 P M

2 Determine the volume and specific gravity of each sample of urine

3 Normal values The night urine will have a volume of from 250 to 500 cc with a maximum of 750 cc The specific gravity will be about 1 018 The day urines will have at least one specimen whose specific gravity exceeds 1 018, and the difference between the highest and the lowest specific gravities will be not less than 8 to 9 points

4 Impaired renal function is shown by (a) nocturnal polyuria—the night sample has a volume of 750 cc or more, (b) a low maximum of specific gravity in the day samples, i e , the highest specific gravity is not over 1 018 (c) a fixation of specific gravity The variations in specific gravity between the many specimens is less than 8 or 9 points This is a most important sign of renal insufficiency The kidneys lose their power to concentrate the urine, so that the specific gravity gradually drops lower and lower as the functional impairment increases

Fishberg's Concentration Test

This test is based upon the specific gravity of three specimens of urine voided at hourly intervals in the morning after a high protein supper at 6 P M , with minimal amounts of fluid the previous evening

1 Have the patient eat a regular evening meal at 6 P M with a minimal amount of fluid and a considerable amount of protein No more fluid is allowed for the duration of the test

2 Discard all urine voided during the night

and globulin fractions is indicated in the study of these disorders Decreased protein is found when there has been plasma loss by ex travasation or albuminuria or when there is impairment of protein synthesis due to malnutrition, defective absorption or liver disease Fractionation of the albumin and globulin takes considerably more time and effort than the determination of total protein and should only be ordered when the information it provides is definitely re quired

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ured concentration of urea in the blood, concentration of urea in the urine and the urine volume per unit of time

1 In the normal adult passing a urine volume of 2 cc or more per minute, the urea excretion is at a maximum value This maximum clearance ranges from 64 to 99 cc , average 75 cc , of blood cleared of urea per minute When the output is less than 2 cc per minute, the volume of blood cleared of urea each minute varies from 40 to 60 cc , with a mean value of 55 cc This is regarded as the standard clearance Results are expressed preferably as percentages of the standard A clearance of at least 60 per cent is acheived by normal kidneys In mild renal impairment the clearance may be 40 per cent, in moderate cases 20 per cent and in severe cases below 20 per cent

2 The test should be done between breakfast and lunch Breakfast should be moderate without tea or coffee The patient should remain quiet during the two hours of the test The height and weight should be recorded

3 After drinking two glasses of water, the patient empties the bladder completely and the specimen is discarded The time is accurately recorded One hour later the patient drinks two more glasses of water and voids completely The specimen is saved and the time accurately noted At the end of another hour the bladder is again completely emptied, this urine also being saved It is not necessary that the urine be passed at exactly hourly intervals It may be longer or shorter The essential things are that the time be recorded exactly and that the complete urine content of the bladder be obtained Provided the time is accurately known, the volume of urine per minute or per hour may be easily calculated

4 Blood is drawn near the midpoint of the test, it may be taken just before or after the second voiding The exact time is unimportant as the fluctuation of the blood urea is but slight over such periods of time

5 Blood and urine specimens are sent to the chemistry laboratory for estimation of urea

6 Calculations are as follows

$$\text{Maximum clearance (as \% of the normal)} = \frac{100 \times U \times V}{75 \times B}$$

$$\text{Standard clearance (as \% of the normal)} = \frac{100 \times U \times V}{54 \times B}$$

U = Urinary urea in mg per 100 cc
B = Blood urea in mg per 100 cc
V = Volume of urine excreted in cc per minute

3 Save the first sample of urine voided in the morning

4 Have the patient rest in bed for an hour Then a second sample of urine should be voided and saved

5 If possible, the patient should arise, and after one hour's activity a third sample of urine should be collected and saved

6 Accurately determine the specific gravity of each of the three specimens If much albumin is present, the specific gravity should be corrected by subtracting 0 003 for each gram per 100 cc

7 Normally the specific gravity of at least one specimen should be 1 025 or higher

Phenolsulfonphthalein Test

The elimination of phenolsulfonphthalein (P S P) may be tested by its administration either intramuscularly or intravenously The dye is available in 1 cc ampules containing 6 mg of P S P

1 Give the patient two glasses of water (300 to 500 cc) to drink Twenty minutes later the bladder is emptied and the urine discarded Inject intramuscularly or intravenously exactly 1 cc of sterile P S P solution, noting the time of injection

2 After intravenous injection, specimens of urine are collected, with complete voiding each time, at fifteen, thirty, sixty and, if desired, 120 minutes Each specimen should be properly labeled and sent to the laboratory for estimation of per cent excretion of P S P

3 The following table gives the normal values for the intra venous method

TIME MINUTES	MINIMUM PER CENT	MAXIMUM PER CENT	AVERAGE PER CENT
15	25	50	35
30	40	60	50
60	50	75	65
120	55	85	70

4 After intramuscular injection, specimens are collected at seventy and 130 minutes from the time of injection and sent to the labora tory for estimation of the percentage of P S P excreted Normally there will be an excretion of about 50 per cent in the two hour period In severe renal impairment, excretion will be below 10 per cent

Urea Clearance

This test is based upon the quantity of blood cleared of urea per minute while passing through the kidneys Three factors are meas

Hippuric Acid Test

The liver forms hippuric acid by combining glycine and benzoic acid The urinary excretion of hippuric acid after administration of benzoic acid may be regarded as a measure of the ability of the liver to furnish glycine and also as an index of its detoxifying activity Fluids must be restricted

1 *Oral Test* Give 5 9 grams of sodium benzoate dissolved in 30 cc of water (flavored with a teaspoonful of cherry syrup) one hour after a breakfast of coffee and toast Use the same glass to give ½ glass of water Immediately thereafter have the patient void urine and discard the specimen Thereafter collect urine at hourly intervals for four hours and mix Send the entire specimen to the laboratory The normal elimination of hippuric acid by the oral method is 3 to 3 5 grams in the total four hour urine

2 *Intravenous Test* This is applicable to patients who are nauseated or vomiting or too ill to be deprived of fluids for the oral test (a) Give breakfast of toast and coffee This may be omitted if the patient is vomiting (b) One hour later have the patient void urine and inject intravenously 20 cc of a sterile aqueous solution containing 1 77 grams of sodium benzoate One hour later collect the urine and send to the laboratory for analysis In the intravenous test the total excretion normally is about 0 7 gram in the total one hour specimen

Bromsulfalein Test

This test depends upon the excretion of bromsulfalein by the parenchymal cells of the liver, aided by destruction of the dye by the Kupffer cells The test is always positive and the readings un satisfactory in marked jaundice, so that it should not be used if visible jaundice exists

1 Weigh the patient The dose required is 5 mg per kg of body weight The dye is available in a 5 per cent solution in ampules, 0 1 cc contains 5 mg, so that the dose is 1 cc for each 10 kg or 22 pounds of body weight

2 Using a sterile syringe inject the dye into an arm vein Take one minute for the injection

3 At the end of two minutes, and again forty five minutes after in jection, draw 10 cc of blood from the other arm Use a dry needle and syringe to avoid hemolysis and collect in a test tube Send the specimens at once to the laboratory Normally not more than 5 per cent of the dye is retained forty five minutes after its administration, and usually only a trace or none at all A retention of 20 to 40

Nitrogen Retention

This is best measured by determination of the nonprotein nitrogen of the blood. It should be determined in patients with albuminuria or abnormalities of the urinary sediment and in patients with hypertension, kidney disease, heart failure and liver disease. It is not a routine procedure. In evaluating the blood nonprotein nitrogen proper consideration should always be given to extrarenal and prerenal factors which may cause elevation of the nonprotein nitrogen in the presence of normal kidneys.

TESTS TO DETERMINE LIVER DAMAGE

(For a fuller discussion see the chapters on the Biliary Tract and on the Liver.)

No single test will indicate the hepatic status, because of the multiplicity of hepatic functions. Liver function changes in the course of a disease and tests must be repeated often during and even long after an acute illness.

Bilirubin in Blood

This is measured either by the icterus index, which is normally five, or by quantitating the amount of bilirubin by a photometric method. By the latter method normal serum bilirubin levels range from 0.08 to 0.82 mg. per 100 cc., in most instances below 0.6 mg.

Bilirubin in Urine

The Harrison spot test is quick and delicate. A small strip of thick filter paper, previously dipped in barium chloride solution and dried, is dipped in urine, dried slightly, and a drop or two of Fouchet's reagent placed on it. A green color indicates bilirubin, which is normally absent in the urine.

Urobilinogen in Urine

A positive test occurs if much of the urobilinogen absorbed from the intestine cannot be excreted because of liver damage. The Wallace and Diamond test utilizes the color produced by diazotization. The patient should void, drink a glass of water and two hours later pass urine for the test. This should be delivered at once to the laboratory, as the test must be done on fresh specimens. The liver is damaged if the test is positive in a dilution of 1:20 or higher. The pigment will be absent soon after bilirubin stops being excreted into the gut.

CHAPTER 44

CLINICAL PATHOLOGY

CLINICAL LABORATORY TESTS

Blood

(For technic of blood grouping see the chapter on the Blood Bank and Blood grouping Technics)

In ordering blood tests every effort should be made to be selective, utilizing only those tests which will yield the desired information. For example, in cases of massive hemorrhage, the hemoglobin at frequent intervals will yield the essential information. Repeated red cell counts will not yield much more detail as a rule.

Hemoglobin. The hemoglobin is determined as acid hematin by adding 0.02 cc. blood to N/10 hydrochloric acid and diluting the acid hematin with water until a color match is attained with nonfading glass standards. The microscope lamp should be utilized as the light source in the color match. When collecting blood for hemoglobin determination or for cell counts, the skin puncture should be deep enough to produce a free flow of blood so that there will not be dilution with tissue juice. The results are best recorded as grams per 100 cc. of blood.

Hemoglobin Content of Red Blood Cells. This is measured in two ways: (1) by the color index and better (2) by the mean corpuscular hemoglobin.

The color index is determined by dividing the percentage value of the hemoglobin by the percentage of red blood cells, assuming 5,000,000 per cu. mm. as 100 per cent. The color index is 1 when each of these values is 100 per cent or when the percentage reduction in both values is the same.

The mean corpuscular hemoglobin (MCH) is determined by dividing the hemoglobin, in grams per liter of blood, by the red cell count. Note that the hemoglobin is usually reported in grams per 100 cc., and must be corrected to grams per liter for the estimation of the MCH. The normal value range is from 27 to 32 micromicrograms in men and women. Hypochromic cells are below this range and hyperchromic cells above it. As the normal red cell is completely saturated with hemoglobin, an MCH of greater than 32 means that the cell size is larger than normal, that is, macrocytic.

per cent indicates slight hepatic damage, 50 to 80 per cent, moderately severe, and 90 per cent or higher, very severe damage

Cephalin Flocculation Test

This test depends upon changes in serum albumin and globulin resulting from liver damage Because of difficulties with the antigen, occasional false positives occur Normal sera may show a one or two plus Three to four plus is generally abnormal The test may become negative in the presence of liver disease

Thymol Turbidity Test

This test is based on the precipitation of a buffered suspension of thymol by certain beta globulins which are increased in acute parenchymal liver disease The normal range is from 0 to 6 units Six to 12 units suggests early obstructive jaundice or inactive cirrhosis or diseases associated with high serum globulins Values above 12 units signify active liver damage, the higher the values, the more severe the damage

Cholesterol and Cholesterol Esters

The cholesterol esters normally make up 75 per cent of the total cholesterol In liver damage this per cent falls, but the total cholesterol does not change markedly

Another blood index is the mean corpuscular hemoglobin concentration (MCHC) This is determined by dividing the grams of hemoglobin in 100 cc of blood by the hematocrit and multiplying by 100 The normal adult range of this value is 32 to 36 per cent Values above 36 are not encountered because the normal red cell is saturated with hemoglobin Values below 33 occur in hypochromic anemia

Determination of the hemoglobin by the photometric method is more accurate than by the standard Sahli method, but utilizes 50 cu mm instead of 20 cu mm of blood

Platelet Count The platelet count is of particular value in differentiating hemorrhagic diseases, for example, in thrombocytopenia purpura the platelets are greatly reduced The normal value for the method described is between 150,000 and 400,000, but the physiologic variation may be even greater A hemorrhagic tendency due to thrombocytopenia is most likely to become manifest when the platelets fall below 60,000 per cc

(1) Puncture the finger (2) Place two drops of platelet stain (modified from that of Rees and Ecker) on the site of the puncture (3) Dilute with one drop of blood so that there is a one to three dilution (4) Pick up on a clean cover slip and rotate (5) Invert on a clean glass slide Seal with paraffin after returning to the laboratory (6) Wipe the diluting fluid from the finger and utilize a fresh drop of blood for a red count (7) Let the preparation stand for at least ten minutes (8) Before counting, insert into the eyepiece a washer or perforated piece of paper to cut down the field (9) Use the high dry objective (10) Count 1000 red cells and the number of platelets seen while counting the red cells Multiply the number of platelets found by the first four figures of the simultaneously done red cell count This gives the platelet count per cu mm

Bleeding Time (Duke's method) (1) Make a stab wound in the lobe of the ear deep enough to allow several drops of blood to flow spontaneously without squeezing As an alternative the finger may be used If it is the hand should be immersed in warm water and the finger rubbed briskly to assure adequate circulation (2) Note the time the first drop appears (3) Remove with filter paper each drop as it forms, care being taken not to touch the skin The size of the blot decreases steadily When bleeding has ceased note the time that has elapsed (4) The time interval between the appearance of the first drop and the removal of the last represents the bleeding time The normal is one to three minutes giving about six blots When the time is moderately prolonged the twentieth blot will be about half the size of the first When it is greatly prolonged, the twen

Hematocrit This is determined by centrifuging 1 cc of blood, rendered noncoagulable by a special mixture of potassium and ammonium oxalate, in a sedimentation tube at 3000 r p m for thirty minutes The volume of packed cells per 100 cc or the hematocrit reading is normally 42 per cent for women and 47 per cent for men Reduction in the hematocrit occurs in anemia, increase in polycythemia The hematocrit rises in hemoconcentration from any cause and falls in hemodilution

1 The mean corpuscular volume (M C V) is determined by dividing the hematocrit, multiplied by 10, by the red cell count in millions The normal range is from 80 to 94 cubic microns Cells within this range are normocytic Cells below this range are microcytic and cells above this range are macrocytic

2 The most accurate measure of red cell size is by direct measurement of the red cell diameter (M C D) through a calibrated micrometer eyepiece and the construction of a Price Jones curve The normal red cell diameter in adults is 7 4 microns

SAMPLE CALCULATIONS

Hemoglobin = 15 gm Red blood count = 5 000 000/cu mm

Mean corpuscular hemoglobin = $\frac{150}{5\ 000\ 000}$ = 30 micromicrograms

Hematocrit = 45 Red blood count = 5 000 000

Mean corpuscular volume = $\frac{450}{5}$ = 90 cubic microns

Hemoglobin = 15 0 gm Hematocrit = 45 0

Mean corpuscular hemoglobin concentration = $\frac{15 \times 100}{45}$ = 33 3 per cent

NORMAL VALUES FOR RED CORPUSCLES AT VARIOUS AGES

AGE	RED CELL COUNT MILLIONS	HEMOGLOBIN GRAMS	VOL PACKED RED BLOOD CELLS PER 100 cc	CORPUSCULAR VALUES: M C V CU MICRONS	M C H MICROMICROGRAMS	M C H C %	M C D MICRONS
5 years	4 6	12 6	37 0	80	27	34	
6–10 years	4 7	12 9	37 5	80	27	34	7 4
11–15 years	4 8	13 4	39 0	82	28	34	
Adults							
Females	4 2–5 4	12 0–16 0	37 0–47 0	82–92	27–31	32–36	7 2–7 8
Males	4 6–6 2	14 0–18 0	40 0–54 0	82–92	27–31	32–36	7 2–7 8

M C V —mean corpuscular volume M C H —mean corpuscular hemoglobin M C H C —mean corpuscular hemoglobin concentration M C D —mean corpuscular diameter

formed, gradually separating from the wall of the vessel in which it is contained and expressing serum The process is completed within eighteen to twenty four hours For the study of retraction 2 or 3 cc of blood is placed in a test tube, incubated at 37°C and observed at hourly intervals The time at which retraction occurs is noted The phenomenon of retractility is apparently due to the presence of blood platelets, for the degree of retractility closely parallels the number of platelets It is entirely independent of the coagulation time This is most typically exemplified in purpura hemorrhagica The coagulum is formed within the normal time, but it retracts very little or not at all, even after standing several days In hemophilia, on the other hand, with a normal number of platelets, the blood coagulates ex tremely slowly, but the clot when once formed has normal retractile power

Sedimentation Rate (Rourke and Ernstene method) This is determined in a tube 120 mm in length, with an internal diameter of 4 mm , graduated from zero to 100 mm A dry mixture of ammonium and potassium oxalate is used as the anticoagulant The normal range with this method is 0 05 to 0 04 mm per minute This method uses a correction for erythrocyte concentration as determined by the hem atocrit It is of particular value in rheumatic infection, tuberculosis and myocardial infarction It is increased, of course, in all acute general infections

(1) Take 5 cc of blood, using a dry syringe and needle, with as little stasis as possible and place in the special sedimentation rate bottle, inverting twenty times The determination of the rate should be made within three hours after the blood is drawn (2) Draw blood from the bottle into a fine pipette, avoiding bubbles (3) Place the pipette into the graduated tube so that its tip reaches the bottom and fill the tube with blood to the zero mark Remove bubbles by drawing a small amount of blood back into the pipette or by touching the bubble with a corner of a piece of gauze (4) Place the tube in a leveled rack and record the drop of the red cells every five minutes for one hour (5) Centrifuge the tube at high speed (3000 r p m for one half hour) and record the hematocrit (6) Sedimentation rate uncorrected in mm per minute = the fall in the fastest ten minute period divided by ten (7) Using the correction chart, find the inter section of the established mm per minute fall and the hematocrit Follow the curve at the intersection back to the heavy normal line at 45 per cent hematocrit Take the reading of mm per minute at that point This equals the corrected sedimentation rate (C S R)

Red Cell Fragility Normally red blood cells begin to hemo

tieth blot may be fully as large as the first (5) In severe anemia the bleeding time may be prolonged to ten minutes In thrombocytopenic purpura and in diseases of the liver with a hemorrhagic tendency and a low blood fibrinogen the time is extended from ten to ninety minutes Note that the bleeding time by this method is not prolonged in hemophilia

Coagulation Time There are several methods for the determination of coagulation time, varying in their results The capillary method described below is not as accurate as the venous method, but it is accurate enough to determine the presence or absence of an abnormal clotting mechanism

1 CAPILLARY TUBE METHOD (a) Secure three capillary tubes about 10 0 cm in length with a diameter of about 0 8 to 1 2 mm (b) Cleanse a finger and puncture deeply to secure free flow of blood Do not squeeze (c) Discard the first 2 drops of blood (d) Secure a third drop of freely flowing blood Note the time (e) Allow each of the tubes to fill with blood Note the time (f) Rest the tubes on the table and at the end of three minutes break off about 1 0 cm length of tubing every thirty seconds and record the clotting time as the interval from the time the blood appeared on the skin until a fibrin thread bridges the broken ends Care and practice are required in the breaking of the tube so as not to break the fibrin thread (g) Note the time If there is no clotting by the time the first capillary has been utilized, proceed in the same fashion with the second and third capillaries (h) The time between the filling of the tubes and the appearance of fibrin threads is the coagulation time The normal varies from three to eight minutes

2 VENOUS BLOOD METHOD Lee and White's venous blood method is utilized where greater accuracy is required (a) The time of this method is counted from the first appearance of blood in the syringe (b) Secure blood with a dry, clean 1 0 cc or 2 0 cc hypodermic syringe, entering the vein quickly and accurately and avoiding suction (c) Place 1 0 cc of blood in a test tube 8 mm in diameter, which has been rinsed with physiologic salt solution (d) Place the tube in a glass of water at about 75° F (23° C), although this is unnecessary if the room temperature lies between 65° and 90°F (18° to 32°C) (e) Tilt the tube at intervals Coagulation is considered complete when the tube can be inverted without displacing the clot (f) The normal coagulation time by this method is five to ten minutes The greater the diameter of the tube the slower the clotting

Clot Retraction Under normal conditions the coagulum begins to retract within a few minutes to one or two hours after it is

The acidity may be determined with litmus paper or more exactly with nitrazine paper

Sugar This is tested for with Benedict's qualitative solution In performing this test it is well to remember that there is a quantitative relation between the amount of urine, the amount of Benedict's solution and the boiling time Improper attention to any of these factors will give wrong results Four measured drops of urine should be added to 2 5 cc of Benedict's solution and placed in a boiling water bath for not less than three nor more than five minutes The boiling time is important as inadequate boiling gives false negatives and prolonged boiling gives false positives After removal from the water bath, the solution should be observed and allowed to cool, as glucose in concentrations of 0 05 to 0 1 per cent will not reduce until the tube cools In lieu of a water bath the tube may be boiled directly over the bunsen burner for thirty to sixty seconds, using a small glass bead as an anti bump

Albumin This is best determined by the nitric acid test This test is not overly sensitive, but can be quantitated with some accuracy (1) Carefully pour a few cc of concentrated nitric acid into a wine glass Fold a piece of filter paper, clinical grade, in the conventional manner Set it in the wine glass with the point of the folded paper touching the surface of the nitric acid Filter a few cc of urine into the nitric acid Remove the filter paper Wait three minutes and read (2) The test is read from zero to four plus A one plus is a white ring at the point of contact, visible only against a dark background In a two plus test the white ring can be seen against any background, but not from above In a three plus test the ring is seen from above, but it is not opaque In a four plus test the ring is opaque when viewed from above Heavy flocculations are also reported at four plus

Acetone This test is also applicable to serum The reagent for the test is a dry powder with the following formula sodium nitroprusside, 1 gram very finely ground, ammonium sulfate, 20 grams anhydrous sodium carbonate, 20 grams These ingredients are mixed completely, but are not ground together The compound should be kept dry at all times The test is performed by placing a small pinch of the powder 5 mm in diameter, on a white filter paper or on a plate One drop of urine or serum produces if positive, a prompt violet color which is absorbed into the paper and may last for several hours The test may be graded from one to four plus depending on the speed with which the color develops, its intensity and duration

Bile This may be tested for by the *foam test* or by the more sensitive *Harrison test* The foam test is performed by shaking

lyze in a 0 32 per cent solution of normal saline In hemolytic anemias and hemolytic jaundice this susceptibility to hemolysis is increased so that hemolysis may begin at 0 7 per cent, 0 6 per cent or 0 5 per cent and may be complete at 0 5 per cent or 0 4 per cent

(1) A 1 per cent saline solution prepared from chemically pure, analytically weighed, freshly dried sodium chloride is used (2) Place ten small test tubes in a rack and number them from 1 to 10 In tube 1 place 0 4 cc of 1 per cent saline, in tube 2 place 0 5 cc and in each successive tube add 0 1 cc more of saline Tube 10 receives 1 3 cc In a like manner, to tube 1 add 1 6 cc of distilled water and to each following tube 0 1 cc less Tube 10 receives 0 7 cc Mix the saline and distilled water in each tube The saline concentrations now vary from 0 2 per cent in tube 1 to 0 65 per cent in tube 10, with intervals of 0 05 per cent Collect 5 cc of blood in a clean dry syringe by veni puncture and place in a sedimentation rate bottle, inverting twenty times to prevent coagulation Place 1 drop of blood in each tube Mix thoroughly but carefully Do not shake After one hour, when cells have settled, or sooner if they are centrifuged, note the dilution at which hemolysis begins by the first indication of a yellow or pink ish color in the supernatant fluid, and note the dilution at which hemolysis is complete by the absence of red cells at the bottom of the tube (3) The fragility test measures the resisting power of the red blood cells to hemolysis by hypotonic salt solution or some other toxic agent In hemolytic jaundice the cells become more fragile In pernicious anemia the cells are normal or nearly so In some cases of obstructive jaundice, hypochromic anemia and polycythemia vera, the red cells may be more than normally resistant to the hemolytic effect of hypotonic salt solution

Urine

All patients should have the urine examined on admission and as frequently thereafter as is necessary in accordance with the diagnosis and clinical condition If abnormalities of the sediment or a positive albumin test occur in spontaneously voided specimens from females, additional specimens should be secured either by catheterization or by proper cleansing of the vulva, and if necessary, with the insertion of a small cotton plug into the vagina to prevent vaginal contam ination of the urine

Routine examination of the urine involves the following determi nations color, acidity, specific gravity, albumin, sugar, acetone, bile and sediment

infestation should not be made unless the parasitic form or its eggs can be demonstrated, as follows

1 DIRECT SMEAR METHOD Place a drop of warm, normal saline and one of D'Antoni's iodine solution at opposite ends of a warm microscope slide With an applicator mix a small amount of fresh fecal material in each drop Place a cover glass over each preparation Examine the saline solution for pus, blood and living parasites Examine the iodine preparation for cysts D'Antoni's iodine solution should be filtered each time it is taken from the stock solution

2 CONCENTRATION METHOD Using two applicators pick up a sample of stool about the size of a hickory nut and place in a test tube Add sufficient warm water to emulsify Then add tap water to within 1 inch of the top of the tube Strain the emulsion through two layers of gauze into another test tube Centrifuge for one minute at 1000 r p m (about half the speed of the small clinical centrifuge) and pour off the supernatant fluid Add tap water again, centrifuge and decant Repeat until the supernatant fluid is fairly clear Make a smear of the sediment, staining with D'Antoni's iodine solution

A second method of concentration, by zinc sulfate, is as follows Prepare an emulsion of the stool from a sample the size of a hickory nut Centrifuge at 2500 r p m (top speed of the clinical centrifuge) for one minute, taking care to balance the test tubes accurately Decant the supernatant fluid and add more water Break up the sediment and thoroughly mix before recentrifuging Centrifuge again for one minute If the second centrifuge specimen is not clear, dilute once again When the supernatant fluid is fairly clear, decant and half fill the tube with zinc sulfate solution having a specific gravity of 1 180 (33 per cent solution) Break up the sediment as before and centrifuge again Carefully remove several loopfuls of material floating on the surface of the zinc sulfate solution and mix with a drop of D'Antoni's iodine on a microscopic slide Mount with a cover glass and examine

In examining for amebae the demonstration of the parasite will depend upon the freshness of the stool and it will be best to examine the stool at the patient's bedside, unless adequate care is taken to keep the stool warm in transit Mineral oil interferes with the examination of the stool for ova and parasites and should not be used as a laxative

Spinal Fluid

The spinal fluid should be collected in three separate test tubes The first tube should be sterile and should contain 6 0 cc for serology,

the urine in a test tube thoroughly, comparing the color of the foam with that of normal urine A positive test shows a yellow foam It should be recorded as one to four plus

The Harrison test is much more sensitive and is suitable for urines which are negative or questionable by the foam test It is conducted as follows Add to 10 cc of urine 5 cc of a 10 per cent solution of barium chloride Mix and filter Spread the filter paper on dry filter paper Add one to two drops of Fouchet's reagent (trichloroacetic acid, 25 grams, water, 100 cc, 10 per cent solution of ferric chloride, 10 cc) A positive reaction yields a blue to green color This test is found to be as sensitive as any of the concentration methods

Gastric Analysis
(See chapter on Gastro intestinal Diseases)

Stool Examination

All surgical patients should have one stool examination, or more if the diagnosis or clinical condition requires The routine examination includes a test for occult blood and a macroscopic examination for color, consistency, the presence or absence of mucus or blood

Occult Blood Smear a specimen thinly over a small portion of filter paper Add three drops of glacial acetic acid and two drops of a freshly prepared gum guaiac solution, made by dissolving 0 5 gm of powdered gum guaiac in 30 cc of 95 per cent alcohol Now add three drops of hydrogen peroxide (The alcoholic gum guaiac is prepared fresh daily by the technicians and kept in the icebox with the hydrogen peroxide) If occult blood is present, some shade of green or blue will develop, depending upon the amount of blood present A blue or green color developing after ten or fifteen minutes is not a positive test Excessive amounts of fat will give false positives If fats are present, they should be removed as follows Place a folded piece of filter paper into a funnel or conical urine glass and in the bottom of the fold place a stool specimen secured with an applicator Extract the fat by adding ether three times Spread the filter paper out flat and proceed as above

Microscopic Examination The microscopic examination of the stool is performed on a thin fecal suspension in water Sudan III stains fat droplets red Muscle fibers may be observed in the unstained specimen

Parasites and Ova Search for parasites and ova, particularly in the presence of eosinophilia, anemia, unexplained gastro intestinal symptoms, chronic or recurrent diarrhea especially if there is blood, mucus or pus in the stool A positive diagnosis of parasitic

(3) The appearance, in a few seconds, of a turbid ring at the point of contact indicates a positive reaction Rings appearing after five minutes are normal

Protein—Quantitative The quantitative determination of total protein is done by a photometric method, wherein the turbidity produced by precipitation of the protein by sulfosalicylic acid is measured The normal range is 15 to 40 mg per 100 cc

Technic for Determination of the Basal Metabolic Rate

(By Benedict Collins Apparatus)

1 Before starting the test ask the patient if on that morning there has been (a) ingestion of food, liquid or drugs, (b) physical exertion of unusual character or (c) mental excitation of unusual degree Any of these may invalidate the test

2 Take and record the patient's pulse and temperature Prepare the apparatus by putting a fresh chart on the kymograph, attaching a clean rubber mouthpiece and filling the pen with ink

3 Turn the two way valve handle to which the mouthpiece is attached so that the patient will breathe room air when first connected with the apparatus

4 Admit oxygen into the spirometer through the appropriate valve, until the pen comes within 1 inch of the bottom of the paper

5 Adjust the metal arm which suspends the rubber tubes so that the rubber mouthpiece comes near the mouth Insert or let the patient insert the mouthpiece so that the flange is between the gums and the lips and the two flat tabs between the upper and lower teeth

6 Apply the noseclip so that the rubber pads are well down on the nostrils, press them together firmly but gently and adjust the thumb screw to hold the noseclip in this position Ask the patient to try to exhale slightly through the nose If this is possible, the noseclip is not properly applied and should be adjusted until exhaling through the nose is impossible The noseclip must be tight but not uncomfortable

7 Once the mouthpiece is in place and the noseclip adjusted, the patient is breathing room air through the slot in the valve Now turn the valve handle at right angles to its original position This connects the patient to the breathing circuit of the machine The oxygen bell should rise and fall with expiration and inspiration, respectively, the pen similarly

8 Set the time clock in motion

gold sol and culture, or 2 0 cc if only gold sol and culture are desired The second tube should contain 1 0 cc if cell count and globulin tests are desired The third tube should contain 3 to 5 cc for chemical tests, such as total protein, chlorides and sugar

Appearance Compare the second or third tube of spinal fluid with a test tube of distilled water If the presence of blood is excluded, any departure from perfect clarity is abnormal If the fluid is distinctly hazy or of a ground glass appearance, total cell count is increased to at least 300 to 700 white blood cells per cu mm Higher cell counts, with bacteria, render fluids turbid or purulent Normal fluids do not form coagula, pellicles or sediments on standing A small amount of fresh blood intimately mixed with the fluid does not produce a coagulum

Cell Count The total cell count should be made immediately after the collection of fluid, while the cells are suspended and before coagula have formed If coagulation does not occur, counts made several hours later or the next day are accurate if the fluid is well shaken If delay is anticipated, a minute amount of potassium oxalate should be added to one of the tubes to prevent coagulation (1) Spinal fluids containing blood introduced by a traumatic tap are unsuited for total cell counts because of the artificially added white blood cells Microscopic blood will increase the total cells and may result in diagnostic errors in diseases in which an increase of total cells runs ordinarily between 20 and 100 per cu mm (2) The diluting fluid, consisting of acetic acid and crystal violet, should be crystal clear and free of artefacts If not, it is clarified by filtration (3) *Draw the diluting fluid to the 1 mark of the white* blood cell pipette Then fill with spinal fluid to the 11 mark Shake well for three minutes Fill the counting chamber and wait for the cells to settle Count all of the cells in the entire ruled area (9 large squares or 0 9 cu mm) Divide by 9 and multiply by 11 This calculation takes into account the dilution factor and gives the total cells per cubic millimeter (4) The total cells will normally be 0 to 10 small lymphocytes per cu mm

Differential Cell Count (1) Centrifuge a fresh specimen of fluid (2) Pour off supernatant fluid and make thin smears of the sediment on slides and dry in air (3) Stain with Wright's stain in the same manner as blood smears (4) Count and classify 100 cells as lymphocytes, neutrophils and monocytes

Protein—Qualitative The Ross Jones test for protein is performed as follows (1) Place 1 cc of saturated ammonium sulfate reagent in a test tube (2) Overlay with 1 cc of the fluid to be tested

SECTION VI

General Preoperative and Postoperative Care

9 After the test has run three minutes, place the leak tester (30 gram weight) on top of the bell for the next two minutes, marking the kymograph paper at the time of onset and offset of the weight

10 Note the thermometer reading

11 The test may be allowed to run the full length or almost the full length of the paper as the drum revolves (twelve to fourteen minutes) or may be stopped after eight minutes, and a second test run after a rest of five minutes

12 At the end of the test, turn the breathing valve back to the room air connection, shut off the clock, and remove the mouth piece and noseclip

13 Ask the patient if the test was comfortable

14 Note the barometric pressure

15 Take the patient's height in stocking feet and his weight in clothes To secure the net weight subtract 4 per cent of the gross weight for men and 2 per cent for women

Example

1 In a man—total or gross weight		200 lbs
	4 per cent of this	8 lbs
	Net weight	192 lbs
2 In a woman—total or gross weight		200 lbs
	2 per cent of this	4 lbs
	Net weight	196 lbs

16 Remove the paper from the drum, draw the line of oxygen consumption and proceed with the calculations

CHAPTER 45

PREOPERATIVE PREPARATION

The preoperative preparation of the patient in many instances begins even before the patient's admission Everything done to the patient from the moment of hospital entry constitutes preoperative preparation Not the least is the psychological preparation If physicians in training realize that the successful practice of medicine is as dependent upon their skill in securing the patient's peace of mind as upon their diagnostic and technical skill, they will not lose the opportunity to give this aspect of their training special emphasis Transplantation to a hospital is a major psychological burden for most people So far as possible the patient's preferences as to habits of living (viz , smoking, alcohol, clothing, food preferences and other idiosyncrasies) should be respected

*Psychological Considerations**

To the patient an operation signifies a threat to life and a considerable amount of suffering It creates speculation on the chances of cure and ruminations on his relationship to the diseased organ and its significance for him in the real and symbolic sense

The degree of the patient's anxiety preoperatively determines in large degree his postoperative reaction If he has been psychically well prepared, the postoperative reaction is more likely to be satisfactory The more acute and unexpected the operation and, therefore, the more unprepared the patient, the greater the likelihood of a postoperative reaction consisting of a state of tension, insomnia, nightmares, vasomotor or cardiorespiratory symptoms Although adequate preoperative preparation aimed at the anxiety state does not necessarily allay the anxiety, it does succeed in getting the patient to set up his inner defenses, so that the preoperative fear is lost postoperatively Some who display no fear preoperatively may develop severe and dangerous postoperative anxiety states The fear reaction is not necessarily proportional to the real danger involved in the surgical attack and may be more closely related to the patient's particular pre existing psychic situation

* Deutsch H Psychosomatic Medicine I 105 1942

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The operation itself represents two things (1) a possible or probable loss of a part of the body and (2) the threat of death The latter is connected with the anxiety related to the anesthesia, which symbolizes a going away from life In some patients a loss of part of the body creates an anxiety related to the fear of castration, a historical residue of which involves the fear of loss of any part of the body especially a diseased one, which has mobilized the patient's psychic energies for some time The best tempered and mildest people may react to this threat derived from the castration complex, by aggressive behavior before or after operation Others may accept surgery as an expiation of guilt and in some cases prolonged convalescence and postoperative depression may be an expression of this sense of guilt A child's violent reaction to narcosis may be due to the implied threat of death considered as a punishment for his own death wish against some person near to him Such behavior may recur in adults at subsequent surgical experiences

A postoperative reaction may resemble one of the two patterns of behavior seen after an unsuccessful attempt at suicide (1) a euphoria as if one were reborn or (2) a depression from unwillingness to survive

In the postoperative state, fantasies in women are more likely to center about the patient's emotional relation to her mother, to childbirth and the fear of death from it In males the fear of castration complex predominates, with a not uncommonly observed pugnacious form of defense during recovery from narcosis

In general, the patient's fear of death makes him strengthen his ties to life by asking for more love from his family and those around him and by loving and trusting his surgeon

Preparation of Normal Patients for Surgery

Any apparently normal well balanced patient may react neurotically to the threat of an impending operation

To condition the average patient for elective surgery, operation is suggested to the patient in a tentative way so as to permit an evaluation of his reaction The response will suggest whether psychiatric consultation is desirable In some individuals even minor procedures like catheterization or lumbar puncture may elicit an abnormal response It is well to bear in mind that surgery upon certain organs, the central nervous system, the eyes the genitalia and secondary sex organs may provoke a more untoward response than surgery upon other organs Mutilating operations on the face, plastic procedures involving the appearance in general, amputations, especially in

younger people, and artificial stomata belong to the most traumatic experiences

When surgery has been decided upon, the patient should be told what will be done, why it should be done, what will be removed, if necessary, the anesthesia which will be used, etc , in simple, clear language, avoiding technical terms which may seem weird and threatening to him Realistic, though carefully weighed, information will help check the patient's usually exaggerated or imaginary fears If he is stable and not unduly sensitive, he will be grateful If he is overanxious and frightened, his questions should be answered with gentleness and patience The discussion should provide an opportunity for the patient to relieve tension and so forestall anxiety or even panic

The doctor must be aware of the doctor patient relationship Patients are inclined to project on to their doctor, especially the surgeon, all sorts of subconscious infantile emotions, such as childhood anxieties, a feeling of dependence, fear of being neglected or punished They acquire implicit trust in the physician's unfailing knowledge, superhuman power over life and death and unlimited interest in the patient This transference relationship is of great importance for the patient's general condition and has a strong influence on the course of the illness, on his reaction to treatment and on his recovery It often determines whether a patient feels overwhelmed by his illness or secure from its dangers The surgeon, therefore, should by his whole attitude and approach avoid anything which may disturb the patient's confidence in him as a considerate, understanding and reliable protector

Preparation and Handling of Children

Much that has been said above for adults holds good for children, but with the following additional considerations

Children have difficulty in seeing far beyond their limited experience They are, therefore, inclined to interpret disease or operation as some sort of punishment or attack upon them They are less rational and more emotional than the average adult and have more difficulty in working off anxieties through comprehension Hence the psychological preparation for surgical procedures ought to be done carefully Sufficient time should be allowed to enable the child to cope with his emotions and to ask questions Because informing the child frequently leads to trying anxiety states and to resulting behavior problems before the operation, parents and doctors are often inclined to hide the pending operation from the child This

The operation itself represents two things (1) a possible or probable loss of a part of the body and (2) the threat of death The latter is connected with the anxiety related to the anesthesia, which symbolizes a going away from life In some patients a loss of part of the body creates an anxiety related to the fear of castration, a historical residue of which involves the fear of loss of any part of the body, especially a diseased one, which has mobilized the patient's psychic energies for some time The best tempered and mildest people may react to this threat derived from the castration complex, by aggressive behavior before or after operation Others may accept surgery as an expiation of guilt and in some cases prolonged convalescence and postoperative depression may be an expression of this sense of guilt A child's violent reaction to narcosis may be due to the implied threat of death considered as a punishment for his own death wish against some person near to him Such behavior may recur in adults at subsequent surgical experiences

A postoperative reaction may resemble one of the two patterns of behavior seen after an unsuccessful attempt at suicide (1) a euphoria as if one were reborn or (2) a depression from unwillingness to survive

In the postoperative state, fantasies in women are more likely to center about the patient's emotional relation to her mother, to childbirth and the fear of death from it In males the fear of castration complex predominates, with a not uncommonly observed pugnacious form of defense during recovery from narcosis

In general, the patient's fear of death makes him strengthen his ties to life by asking for more love from his family and those around him and by loving and trusting his surgeon

Preparation of Normal Patients for Surgery

Any apparently normal well balanced patient may react neurotically to the threat of an impending operation

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rent with, but not clearly related to, the surgical condition Such disorders may complicate the diagnosis or response to treatment

d Any unusual mental reaction or attitude toward the illness, hospitalization, diagnosis or the suggested operation or treatment The reaction may take the form of an overemotional or an abnormally indifferent response In most patients severe organic conditions provoke or activate neurotic anxieties and excessive fear Even a minor organic change, and especially any surgery, may arouse fear of destruction or mutilation

Evaluation of a Psychiatric Disorder

There is no test which is pathognomonic of psychoneurosis A psychiatric diagnosis cannot be made by exclusion It is based on judgment made from

1 *The Nature of the Patient's Complaint* The complaint may be disproportionate, fantastic (not explicable on the basis of any recognized organic disease), multiple, embracing incompatible symptoms or symptoms inconsistent with the organic condition There may be conspicuous understatement or denial of symptoms in the face of obvious disturbances, even to the point of showing signs of enjoying the disease There may be overtones of despondency or aggressiveness

2 *The History of the Patient* Previous episodes of neurotic or psychiatric disturbances, such as anxiety, phobias, compulsions, depression, delirium, hallucinations, commitment, frequent accidents or a conspicuous number of operations of doubtful necessity

3 *The Personality of the Patient* The psychological response to the hospital environment—overemotional, withdrawn, hostile, sensitive, suspicious, demanding, submissive, etc

4 *Obvious Psychoneurotic Symptoms*

PSYCHOTIC PATIENTS

Patients with a psychosis may be hospitalized because of a surgical emergency The psychosis may appear only after a period of hospital stay A psychosis should be suspected when wounds are self inflicted or when foreign bodies have been inserted into various apertures Subdural hematoma should be remembered as a cause of psychosis

General Instructions in the Care of the Psychotic

Operations ordinarily performed under local or spinal anesthesia may require general anesthesia in patients unable to cooperate

technic is more for the benefit of the family and hospital routine than for the benefit of the child It may result in less noisy behavior pre operatively, but produce greater postoperative psychological trauma to the child In children, such trauma is likely to become the basis of neurotic disturbances in later life A further specific point with children is their complete emotional dependence on parents or parent substitutes One of the most frightening parts of hospitali zation is the separation from parents As far as possible, parents, or a person to whom the child is attached, should be present before and after the operation and act according to the advice of the doctor But only such parents as are relatively balanced should be permitted to do this because mothers in panic or with a poorly hidden anxiety can upset the child more by their presence than by their absence A calm, confident, friendly environment is of the greatest significance for the child's well being

Finally, attention should be paid to the child's tendency to endow inanimate objects with special qualities and powers Often a Teddy bear, doll or little gadget which a child uses to take to bed with him possesses great magical strength for him Therefore, the child clings to it in times of crisis He should be allowed to take it to the hospital, even if it is a little dirty, so long as hygienic standards are not vio lated

In addition to these special considerations, the usual considerate methods of handling children, including the use of mild preoperative medication to decrease anxiety, often result in the child's being a reasonable, confident and grateful patient

PSYCHIATRIC CONSIDERATIONS IN SURGERY

1 A psychiatric consultation is advisable when a patient presents one of the following problems

a An organic condition in which there is a possibility that emotions are important as precipitating or aggravating factors e g , peptic ulcer, hypertension, asthma

b Psychological disturbances leading to symptoms simulating those caused by surgical conditions and not associated with demon strable organic disease e g , hysterical patients who feel pain or produce pareses on a purely psychogenic basis, hypochondriacal patients or those with delusions referred to some part of the body Such patients are convinced that they have organic disorders, which they are ready to describe in detail

c Neurotic disturbances (tics, phobias stammering) or psy chotic disturbances (depression, paranoid states) existing concur

cent If it is below this value, transfusions should be given before operation to bring it up to or well beyond this minimum level Donors should be obtained for patients whose blood volume is low or may become low, whether because of actual blood loss at operation or for any other reason, such as plasma loss from intestinal obstruction

Anxious, sleepless or restless patients should receive phenobarbital during the day and for sleep Cathartics and laxatives aggravate postoperative distention and are not used for preoperative preparation A saline or soap suds enema may be given the evening before or the morning of operation, but it is not always necessary to do so, as in minor surgery, emergency surgery or when the patient is likely to be ambulatory soon after operation

Since inhalation pneumonia may occur if aspiration of saliva occurs, either during anesthesia or under sedation, mouth care preoperatively requires the eradication of existing sepsis of the mouth, nose or throat This may require, in addition to routine mouth hygiene, dental consultation for the removal of loose teeth or the correction of alveolar sepsis or treatment by the rhinolaryngologist These precautions apply even when regional or local anesthesia is to be used, because it is not infrequently necessary to supplement with general anesthesia

The *stomach must be empty before operation* to avoid aspiration pneumonia This is why food is withheld on the morning of operation In emergency surgery requiring general anesthesia, a *gastric lavage* is required unless the patient has not had food for at least four hours If there is considerable gastric residue, the tube is left in If the surgery involves the upper gastro intestinal tract, or if a small bowel resection may be required, the tube is put in regardless of the preoperative gastric content

Prophylactic chemotherapy should be started as soon as possible, preferably several days before operation, when there is active infection that may be aggravated by the surgical procedure, e g , in lung abscess, bronchiectasis, subphrenic abscess, peripheral vascular disease with open lesions and similar disorders Elderly and debilitated patients, especially those who require abdominal surgery, should also receive prophylactic chemotherapy to avoid a postoperative pulmonary complication If a gastro intestinal procedure involving an opening into the bowel lumen is planned, streptomycin ¼ gram, q i d , is given *orally* for two or three days in advance of operation Where drug expense is an important consideration, sulfathalidine 2 to 3 grams, q i d , is an acceptable substitute

Elective operations that depend for success upon the patient's co operation postoperatively are contraindicated in psychotic patients

Special nursing care often is indicated in the management of acutely disturbed patients The presence of a nurse serves as a source of stability in a social environment that is otherwise inconstant and bewildering to the patient The nurse also provides reassuring contact with reality through such simple devices as reminding him where he is and what is going on Disturbed patients frequently are unable to cooperate adequately in taking medication and food unless given special nursing attention

Since psychotic patients are aware of what is going on about them, they must be protected from remarks that might add to their discomfort When simple requests and persuasion fail to bring co operation, arguments and threats are to be avoided, as they may lead to the patient's becoming further distressed and even more difficult to manage

Sedative drugs in small doses are not very useful in the psychoses When rest is required, it is better to administer a single sleep producing dose Barbiturates, especially in delirium and in older people, may aggravate excitement and agitation Paraldehyde is preferable The opiates are almost never required in the handling of psychiatric disorders *If the doctor is able to sit down at the bedside* for a few minutes to let the patient express himself freely, he will be in a position to be more effective than if he routinely orders pharmac ological sedatives or mechanical restraints Occasionally, cloth bracelets or anklets are required to protect a patient from disturbing a vital dressing or endangering himself by getting out of bed

When a patient shows signs of a tendency to suicide, a psychiatric consultation is desirable One should be alert for such a tendency if there is a history of a recent serious depression, attempted suicide or conspicuous failure to follow medical advice, verbal suicidal threats or evidence of depression or confusion or paranoia Such patients should be provided with uninterrupted special nursing attention and antisuicidal precautions should be taken

General Preparation

The patient should be well hydrated and anemia corrected as far as possible If the surgical procedure involves more than a slight blood loss (more than 250 cc), the patient should be typed and cross matched with donor blood The Rh must be determined in every case, whether transfusion is or is not anticipated The minimum hemoglobin concentration for surgery should be not less than 65 per

more generous area than is likely to be exposed at operation Thus, for a mastectomy, the entire anterior chest, both shoulders, the axilla, the ipsilateral back of the chest and the whole neck are prepared For varicose veins, the lower abdomen, perineum and entire leg are prepared It is preferable in elective cases to have the shave per formed forty eight hours in advance, if it can be managed, because a freshly shaven skin is less resistant to infection than one less recently shaven The prepared field need not be covered with a dressing

The antiseptic preparation of the operative site consists in working up a lather of cocoanut oil soap with a soft sponge and scrubbing for two minutes Then the area is shaven and this is followed by a wash with warm water The razor should be new or sterilized to avoid cross contamination

Aseptic preparation of skin should have regard for the fact that while transient organisms which may be free or held by grease or fats can be removed by mechanical and antiseptic measures, the resident bacteria in sebaceous glands and hair follicles cannot be re moved Scrubbing to remove transient bacteria must be applied with equal energy to all smooth areas and with additional effort in creases and folds (e g , knuckles, groins, umbilicus, perianal, perineal areas) The germicide which is applied must have time to act upon them, must be in effective concentration, and rubbed in so as to penetrate to the resident organisms as far as possible, because they rise to the surface during operation Soft and delicate tissues are scrubbed with soap and water, but the antiseptic (preferably 1 1000 aqueous "zephiran") is applied as a wet dressing for thirty minutes, rather than rubbed in

The choice of antiseptic is reasonably wide and includes 70 per cent alcohol by weight, 30 to 50 per cent isopropyl alcohol, aqueous solution of iodine and, best of all, cationic detergents such as the quaternary ammonium salts, among which benzyltrialkonium chloride ("zephiran") is a good example Phenols, cresols, "metaphen," "merthiolate," "mercresin," "mercurochrome" and mer curic salts are not reliable against resistant spores

The *bladder should be empty* when the patient goes to the operating room Operations on the perineum, female genital tract, rectum, sigmoid, and laparotomy for surgery in or near the pelvis require that the patient be catheterized before entering the operating room The catheter should be left in and held securely in patients who are to have an abdominoperineal resection

Special preparation is required for special conditions e g , patients with *jaundice* receive vitamin K preoperatively until the prothrom

Surgery on patients with acute upper respiratory infection should be postponed until the acute process has subsided, unless emergency surgery is required. In the latter case, and in patients who have recently recovered from an upper repiratory infection, prophylactic chemotherapy is begun before operation and continued for several days thereafter to forestall a pulmonary infection.

The best possible nutritional status attainable should be achieved. It is a common experience for the surgeon to have to operate upon patients with severe nutritional deficiencies, which cannot be wholly corrected except by the surgery required. The general and specific directives for preoperative nutritional care in various circumstances are discussed under special conditions and in the chapter on Nutrition in Surgical Patients.

Excessively obese patients requiring urgent surgery, particularly in the abdomen, are poor risks apart from the presence of demonstrable cardiovascular disease, which is so commonly present among them. They not only offer technical difficulties to the anesthetist and the surgeon, but are prone to develop pulmonary complications, severe ileus, infection of subcutaneous fat layers, etc. If the surgery is elective, satisfactory weight reduction should be insisted upon beforehand.

Children are a special problem. The fluid and electrolyte balance and nutritional status should be cared for by the pediatrician, both preoperatively and postoperatively. The thymus gland precautions of former years are no longer considered valid.

The cardiovascular and renal status of all patients must be accurately assessed. (These topics are discussed under their appropriate headings elsewhere in this volume.)

Pregnant women should not have major elective surgery performed. Necessary surgery usually is concerned with an ovarian cyst or fibroids which may interfere with pregnancy or labor, or with acute appendicitis. A diagnosis of appendicitis is sometimes made incorrectly because of persistent pain in the right lower quadrant. Because pain in this region is common in pregnancy, true appendicitis may be overlooked and if so widespread peritonitis is very likely.

Preanesthetic Medication
(See Anesthesia)

Preparation of the Field

The house officer should inspect the prepared field to be sure that the shaving and the size of the field is adequate. This means a far

more generous area than is likely to be exposed at operation Thus, for a mastectomy, the entire anterior chest, both shoulders, the axilla, the ipsilateral back of the chest and the whole neck are prepared For varicose veins, the lower abdomen, perineum and entire leg are prepared It is preferable in elective cases to have the shave performed forty eight hours in advance, if it can be managed, because a freshly shaven skin is less resistant to infection than one less recently shaven The prepared field need not be covered with a dressing

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Special preparation is required for special conditions e g , patients with *jaundice* receive vitamin K preoperatively until the prothrom

bin time is normal If the case is urgent, intravenous vitamin K_1 oxide will produce a normal prothrombin time within twelve hours *

(For more data on preoperative preparation consult the chapters *dealing with specific surgical disorders and with medical conditions* complicating surgical disorders)

SURGICAL RISK

The grading of risk is not subject to precise evaluation Any major medical disorder, apart from the disease requiring operation, neces sarily increases the risk of major surgery Over all estimation of risk is a process of judging the extent of depletion of the patient's reserves of major physiologic function This is why a complete exam ination is an indispensable feature in the care of the patient

Objective data help substantially to assess the risk and to deal with it But in many instances a large area of uncertainty still re mains The patient's appearance may suggest to the experienced physician a degree of risk which exceeds that estimated from the objective data Facts from the history or certain intangibles influence his judgment Depletion which cannot be measured may enter into the final assessment Apart from psychic factors that resist evalua tion body responses to physical and mental stress are probably more widespread and varied than is generally appreciated Moreover, intelligent therapy, surgical or otherwise, must take account of the mechanisms of defense induced not only by the disease being treated, but by the treatment itself Surgery, anesthesia and medication are therapeutic measures which in themselves constitute stress in varying degree The defense reaction to stress is by no means always benign and varies from one patient to another, depending on the quality of resistance the patient can set up The poor response of a malnour ished, debilitated patient to a dose of morphine or an amount of surgical trauma which a robust and well nourished person tolerates with ease is all too familiar †

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* Davis W A *et al* Arch Surg *46* 296 1943

† Why this is so is by no means clear although Selye has offered a stimulating hypoth esis to explain this phenomenon He postulates the existence of an adaptation response to continued stress in which the hypophysis secretes corticotrophins at the expense of a diminished secretion of other hormones with a twofold result (1) an overactive adrenal cortex producing organic and inorganic metabolic changes involution of lymphatic tissues release of gamma globulins etc and (2) inhibition of somatic growth involution of gonads amenorrhea etc The energy required to resist continued exposure to stress may exhaust the powers of resistance displayed by this adaptive reaction so that the imposition of a new trauma elicits only an alarm reaction i e catabolic phenomena against which defense can no longer be set up (Selye H Endocrinology Acta Endo crinologica University of Montreal 1947)

Neurologic disease *per se* rarely constitutes a contraindication to operation Patients with recent cerebral accidents should be individually evaluated Debilitated, vitamin deficient, senile or cerebral arteriosclerotic patients are especially liable to develop postoperative peripheral neuropathy, psychoses or cerebral accidents These deficiencies should be corrected as far as possible preoperatively Elective operations should be delayed or avoided on patients having signs suspicious of brain or spinal cord tumor Patients with myasthenia gravis should not be operated upon unless carefully safeguarded by injections of prostigmine In chronic alcoholics there is danger of precipitating delirium tremens by surgery

The choice of the anesthetic in some instances of neurologic disease requires careful judgment Spinal anesthetics may aggravate spinal cord disorders in which impairment of cord circulation exists, especially when prolonged surgery is anticipated

During operation nerve palsies may result from prolonged pressure over nerve trunks by tourniquets or by unusual positioning of the patient, particularly in debilitated, vitamin deficient or elderly subjects

Cardiovascular, respiratory, renal and hepatic function can be assessed with some degree of accuracy, so that if the patient has congestive failure, emphysema, fixation of specific gravity of the urine, cirrhosis, etc , one can be forewarned as to the measures required to prevent collapse of vital functions Elective surgery obviously is unwise until the best possible improvement of such defects is obtained Even when the need for surgery is urgent, much can be done in a short time to improve function, though it may not be possible to restore the optimum state which other circumstances might permit The surgical disorder sometimes compels the imposition of the burden of surgical trauma before any reserve can be built up, as in a patient in shock from massive intraperitoneal hemorrhage Even so, the primary deficiency, a depleted blood volume, can be met concomitant with the surgical procedure The limitations of therapy or the irreversibility of organic damage often compel the surgeon to inflict surgical trauma in the face of more or less risk All that can be expected of him is that the risk be reduced to the minimum

bin time is normal If the case is urgent, intravenous vitamin K_1 oxide will produce a normal prothrombin time within twelve hours *

(For more data on preoperative preparation consult the chapters dealing with specific surgical disorders and with medical conditions complicating surgical disorders)

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If there is asystole, the surgeon must act while the anesthetist maintains respiration If the abdomen is open, the most effective maneuver is direct cardiac massage, which is more satisfactory than intracardiac drugs A rapid incision in the anterior attachment of the diaphragm in the midline to allow massage of the ventricles forty times per minute may be tried When the heart begins to beat again, the hand is removed from the heart, but one is prepared to repeat the massage As a last resort, 3 to 5 minims of 1 1000 epinephrine into the right auricle may be tried

The accidents resulting from local and spinal anesthesia are discussed under corresponding headings below

CONTRAINDICATIONS TO ANESTHETICS

The ideal anesthetic should produce complete relaxation, keep the patient asleep or mentally placid It must not explode and it must have a fair margin of safety between effective anesthetic dose and fatal dose No one anesthetic fully meets all these requirements As a rule, there is more than one choice of a satisfactory anesthetic This is determined by the needs of the surgical procedure and the circumstances of the case

Contraindications to anesthetics may be relative or absolute a relative contraindication to spinal anesthesia is marked hypertension, an absolute contraindication is severe traumatic shock

The absolute contraindications to ether anesthesia are (1) acute upper respiratory infection, (2) acidosis, (3) congestive cardiac failure, (4) electrosurgery in the upper respiratory tract, (5) non protein nitrogen above 40 mg per 100 cc , (6) stomach full of food

The absolute contraindications to *prolonged* administration of nitrous oxide and oxygen are (1) hemoglobin below 50 per cent, (2) Negro and jaundiced patients, (3) congestive cardiac failure, (4) anoxia, (5) stomach full of food

The absolute contraindications to cyclopropane anesthesia are (1) thyrotoxicosis, (2) electrosurgery, actual cautery, or portable x ray in the operating room, (3) auricular fibrillation, (4) acidosis, (5) stomach full of food

The absolute contraindications to avertin by rectum for basal anesthesia are (1) inflammatory disease of the rectum or colon, (2) jaundice or cirrhosis of liver, (3) nonprotein nitrogen above 40 mg per 100 cc , (4) shock, (5) anoxia

The absolute contraindications to intravenous sodium pentothal anesthesia are (1) jaundice or cirrhosis or other severe damage of

CHAPTER 46

ANESTHESIA

ANESTHETIC ACCIDENTS

During general anesthesia 90 per cent of the accidents are due to obstruction of airway The prone position on the operating table interferes with freedom of movement of the diaphragm and causes undesirable circulatory changes, and should be avoided whenever possible Pharyngeal obstruction manifests itself by snoring and may be corrected by changing the position of the head or by pulling the mandible upward and forward Active laryngeal reflexes cause most of the difficult obstruction problems during general anesthesia Partial laryngeal obstruction is indicated by stridor This may be corrected by increasing the oxygen tension in the inhaled gas and deepening the level of anesthesia At times increased pressure in the breathing bag will eliminate stridor If it persists, tracheal intubation is performed Respiratory obstruction from secretions is avoided by frequent aspiration of the nose, pharynx and trachea, when necessary Secretion in the lower respiratory tract may require suction by a catheter in the trachea

If breathing stops, artificial respiration, which must always be available, is started at once, no matter what the cause The simplest and most satisfactory method for maintenance of artificial respiration in an operating room is by manual compression of a bag of oxygen attached to a closed system apparatus Most failures to maintain adequate artificial respiration are the result of obstruction in the upper respiratory tract Having first ensured a free airway, manual compression of a bag of oxygen, with the face mask held tight, is done with just enough pressure to make the epigastrium move slightly Wide movements of diaphragm and chest indicate too much pressure and should be avoided Manual compression of the oxygen bag twelve to sixteen times per minute is adequate As soon as the epigastrium moves upward slightly, the hand is removed from the oxygen bag and exhalation occurs The use of the E and J or Emerson resuscitator is just as satisfactory as the manual compression method In the absence of apparatus, the Silvester arm abduction method or mouth to tube insufflation may be used

The usual preliminary medication for regional or general anesthesia for the average adult is as follows Sodium pentobarbital 0 09 gm the evening before operation Repeat sodium pentobarbital 0 09 gm two hours before operation Morphine sulfate 0 01 gm and scopolamine hydrobromide 0 4 mg or atropine sulfate 0 4 mg subcutaneously are given three quarters of an hour before operation In the aged, jaundice, cirrhosis of the liver, the severely malnourished, shock or incipient shock and in myxedema, the sodium pentobarbital is omitted and the dose of morphine sulfate reduced to 5 to 7 mg or omitted altogether In the aged, when a "drying" agent is desired, atropine is more satisfactory than scopolamine because of the excitement that scopolamine may cause occasionally In the young and in middle aged adults, scopolamine is a better "drying" agent than atropine

TYPES OF ANESTHESIA

Inhalation Anesthesia

The only gaseous anesthetics which will not ignite and not explode when administered with oxygen are nitrous oxide and chloroform

Gaseous anesthetics vary in ability to produce skeletal muscle relaxation Ether and chloroform are the most potent If these are graded 100 per cent from this standpoint, the other inhalation anesthetics rank as follows vinethene 90 per cent, cyclopropane 80 per cent, ethylene 70 per cent, nitrous oxide 60 per cent It is important to understand this varying ability to produce skeletal muscle relaxation because different surgical procedures require different degrees of it Less potent anesthetics allow the activity of reflexes which may tax even the experienced anesthetist Intraperitoneal operations require the highest degree of relaxation Extraperitoneal operations require less relaxation, providing reflex activity is not too high Heavy preliminary medication, basal anesthesia with avertin and local anesthesia decrease reflex activity, and so permit the use of less potent anesthetics Even with these aids the degree of relaxation cannot be predicted If enough is not obtained at the time of administration, one should be prepared to add ether to the anesthetic mixture Therefore, one should not promise the patient or surgeon that ether will not be used

In children under twelve years of age anesthesia is induced by open or semi closed administration of nitrous oxide and oxygen or by open drop vinethene, and maintained by open drop ether or by ether with a cone For adults semi closed or closed technics are more satisfactory

the liver, (2) nonprotein nitrogen above 40 mg per 100 cc, (3) shock, (4) chronic asthma, (5) anoxia

The absolute contraindications to local anesthesia or nerve block are (1) infection at the site of injection, (2) a definite history of untoward reaction following previous injection of a local anesthetic

The absolute contraindications to spinal anesthesia are (1) infection at the site of injection, (2) shock, (3) acute anemia, not corrected, (4) congestive failure, (5) central nervous system lues

PRELIMINARY MEDICATION

The chief purpose of preliminary medication is to control apprehension before induction of anesthesia Frequently the mental depression is accompanied by depression of reflexes, making induction of anesthesia easier

The dosage of soporifics and narcotics used for preliminary medication should avoid depression of respiration and drop in blood pressure But the variation in response of individuals to given doses makes it difficult to select accurately a dosage that will always give just the effect desired In general, individuals who are high strung, alcoholics and those with increased metabolic activity take larger than average doses to get a desired effect Children, old or debilitated patients and those with decreased metabolic activity require smaller doses The depressing effect of average dosage may be severe and even fatal in very debilitated or old patients If barbiturates have been used and the depression is excessive sodium succinate, in 30 per cent solution, is given intravenously Initially a 3 to 5 cc dose is given and then 1 cc per second This may be increased according to the patient's responses, until normal respiratory reflexes and consciousness are restored

Because general anesthesia may be required at any time during an operation started with a spinal or regional anesthetic, it is necessary to reduce secretory activity of the upper respiratory tract Therefore, preliminary medication always includes atropine sulfate or scopolamine hydrobromide

Children rarely show depression of mental activity following ordinary doses of soporifics and narcotics and therefore should be given only atropine sulfate as preliminary medication The depression of respiration and blood pressure by avertin precludes its routine use in children But if one wishes complete mental comfort in a child before operation, it may be necessary in an obstreperous child to use a basal anesthetic such as avertin

h Death from pentothal anesthesia is most likely in operations on the neck

Local Anesthesia

The most satisfactory local anesthetic is procaine in 0 5 per cent or 1 per cent solution The average healthy adult will tolerate 200 cc of 0 5 per cent procaine well, but the site of injection is of some importance Absorption from the neck and deep layers of the back is faster than from other parts of the body, except the pleural and peritoneal cavities This should be kept in mind when large amounts of procaine are infiltrated Soluble barbiturates increase the minimum lethal dose of procaine three to four times and should be used if a toxic reaction occurs Preliminary sodium pentobarbital to inhibit the adverse effects of procaine cannot be relied upon

Dangerous reactions to procaine may result from unintended direct intravenous injection or from excessively rapid absorption These reactions are of three types

a Rapid cardiovascular collapse during the injection of procaine

b Signs and symptoms of central nervous system stimulation, followed by depression ten to twenty minutes after injection of procaine The patient suddenly becomes alert and apprehensive This may be followed by twitchings, tonic and clonic convulsions, loss of consciousness and finally respiratory paralysis Prompt treatment is essential to avoid death

c An anaphylactic reaction in the form of asthma, urticaria or angioneurotic edema, which may be due to the fact that procaine has a benzine ring structure

Treatment of Reaction Type a If the patient faints, lowering the head may be sufficient If the collapse is severe and rapid, death may occur so suddenly that treatment is of no avail Use intravenous glucose, neosynephrin and administer 100 per cent oxygen

Type b Same as for type a, plus 2 5 per cent pentothal sodium intravenously The pentothal is given until convulsions stop If respiration stops, artificial respiration, using 100 per cent oxygen, is combined with tracheal intubation For asystole see the section above on "Anesthetic Accidents"

Type c Give 3 minim doses of 1 1000 epinephrine subcutaneously as necessary or try pyribenzamine

Local anesthetics should not be injected directly into inflamed or infected areas because it may mechanically disseminate the infection Local anesthetics are less potent in inflamed areas because the lower *p*H in inflamed areas results in slower dissociation to the free

The cone must have adequate air space between the face and the gauze on which the liquid is dropped to allow for vaporization The gauge of the cloth must allow free passage of air

The semi closed and closed technics for adults are satisfactory only if the anesthetist pays primary attention to the patient and second ary attention to valves and wheels of an apparatus There is no anesthetic apparatus which will run itself and assure good, safe anesthesia Close attention to the patient during anesthesia and proper provision for free respiration, with constant maintenance of a proper breathing atmosphere, assure good, safe inhalation anes thesia On the other hand, a defective or poorly applied apparatus may lead to serious difficulty Whenever the conditions are not sat isfactory, the inexperienced anesthetist should without hesitation change to simple open ether administration

Intravenous Anesthesia

Pentothal sodium and evipal are very short acting barbiturates They are used for procedures of less than thirty minutes' duration, not requiring much relaxation The dosage, action and effects of these two drugs are so similar that pentothal sodium is used almost exclusively Pentothal sodium is partly detoxified by the liver and partly excreted unchanged by the kidneys It is not used in severe liver or renal disease Attention is drawn to the following points

a The concentration of the injected solution must not exceed 2 5 per cent

b Preliminary medication should be atropine sulfate only

c Inhalation of oxygen or 50 per cent oxygen and 50 per cent nitrous oxide during induction and maintenance of pentothal anes thesia is desirable

d Attention to the free airway is just as important as during inha lation anesthesia The margin between marked depression of reflex activity and respiratory paralysis is too small to allow its safe use as a complete anesthetic for intraperitoneal surgery If used as a basal anesthetic, it is combined with local or regional anesthesia

e Vomiting during pentothal anesthesia, even in the presence of a full stomach is very rare Hence it is suitable for the emergency re duction of simple, readily reduced fractures in patients with full stomachs

f Pentothal sodium is a parasympathetic stimulant and may produce laryngeal and bronchial constriction unexpectedly

g Intrapharyngeal or laryngeal procedures done under pentothal must be combined with topical anesthesia

toxic absorption or advancing infection from hopelessly devitalized parts of an extremity until amputation can be performed This is especially the case in old, debilitated or toxic patients The part to be removed is packed in ice or immersed in a bucket of chilled water (sitting position) until sensation is abolished

A tourniquet applied below the level of the intended amputation, will hasten thorough chilling of the deep tissues The foot must be come pale white but not swollen Pain stops in fifteen to thirty minutes

Spinal Anesthesia

The choice of agent depends on the expected duration of operation Of the agents in common use, in average dose, procaine is effective for one hour, pontocaine for one and one half hours and nupercaine for two and one half hours The duration of anesthesia varies in different areas, longest in the perineum and shortest in the upper abdomen For example, pontocaine given in a dose producing sen sory anesthesia up to D 4 gives one hour of anesthesia in the upper abdomen, one and one half hours in the lower abdomen, and three hours in the perineum and legs When the duration of operation is doubtful, it is preferable to have too long rather than too short an anesthesia In poor risk patients and in cases in which the required duration of anesthesia cannot be approximately predicted, continu ous spinal anesthesia is preferable It permits control of dosage and flexible adjustment of the level of anesthesia

All patients receive 50 mg of ephedrine sulfate or 3 mg of neo synephrin in the deltoid just before the lumbar puncture This pre vents rapid hypotension during the first ten to twenty minutes after induction of spinal anesthesia The dose is repeated during operation if the blood pressure falls to a critical level, below 90 to 100 systolic If a rapid effect is desired, 10 mg of ephedrine sulfate or 0 5 mg neosynephrin is given intravenously A pressor effect occurs in fifteen seconds if the drop in blood pressure is due to spinal anesthesia and not to blood loss If a pressor response does not occur, intravenous glucose in saline or, better, whole blood is needed

Oxygen should be used freely during spinal anesthesia and particu larly during the first half hour of high spinal anesthesia The critical period of spinal anesthesia is the first half hour, during which deaths from spinal anesthesia occur If close attention is paid to maintenance of adequate blood pressure and good oxygenation, spinal anesthesia fatalities will be exceedingly rare even in bad risk patients

basic form It is in this free basic form that they become lipoid soluble and, therefore, active

Most local anesthetics are tertiary amines which are detoxified by the liver Use them cautiously, therefore, in severe liver damage

Intravenous procaine can stop ventricular fibrillation induced by cyclopropane or epinephrine As much as 200 cc of a 0 1 per cent solution may be safely injected in a period of twenty minutes

For anesthesia of mucous membranes, 2 per cent butyn sulfate is better than cocaine, because it is safer Other anesthetics for topical application are ½ or 1 or 2 per cent pontocaine and for the eye or urethra 1 to 2 per cent metycaine

Epinephrine, which is used to delay absorption and so prolong the action of the anesthetic, may be dangerous because its absorption produces especially undesirable effects in patients with coronary disease or angina When used with novocain for anesthesia of a digit, it has resulted in ischemia leading to necrosis Thyrotoxic and diabetic patients may react adversely to epinephrine Epinephrine therefore should not be added to novocain preparations unless special circumstances justify its use

Rectal Anesthesia

The common rectal anesthetic, tribromethanol in amylene hydrate (avertin) has too small a margin between complete muscular relaxation and respiratory paralysis to allow its use as a complete anesthetic Therefore, it is used in less than full anesthetic dose as a basal anesthetic and is supplemented by a gaseous anesthetic or by local anesthesia All avertin solutions before injection must be tested with Congo red as an indicator If the reaction is acid the solution has decomposed and is irritating to mucous membranes The average dose of avertin is 80 mg per kg body weight (100 mg per kg is maximum) No preliminary medication except atropine sulfate is given Depression of respiration with cyanosis must be treated by oxygen inhalation and acute hypotension by parenteral ephedrine sulfate or neosynephrin Epinephrine should not be used because of the possibility of causing ventricular fibrillation during avertin anesthesia Because avertin is detoxified by the liver and is excreted by the kidneys, it is contraindicated in lesions of these organs

Refrigeration Anesthesia

Refrigeration anesthesia is not desirable for tissues which have to survive after surgery, but it is useful to relieve the pain and prevent

The position of the patient on the table is not too important when using procaine or procaine plus pontocaine, except that rapid changes from the horizontal position must be avoided Slow changes in position may be made at any time, but it is better to wait about ten minutes after injection of the anesthetic

Nupercaine The solution of 1 1500 nupercaine in 0 5 per cent saline is injected in fractional doses in the third lumbar interspace with the patient in the prone position after inserting the needle The first dose is 10 cc Five cc is then injected every five minutes until the desired level of anesthesia is obtained The patient is then turned to the supine position with the table level

Intocostrin

The extract of purified curare, "intocostrin," is a useful adjunct to anesthetic drugs It is not an anesthetic and does not relieve pain in the conscious patient It produces skeletal muscle relaxation by blocking acetylcholine at the myoneural junction There is some evidence of central depression by the drug *Prostigmine, 1 cc of a 1 2000 solution given slowly intravenously*, is an *antidote for intocostrin*, but reliance upon it is dangerous if respiratory depression or paralysis develops Intocostrin must never be used unless the anesthetist is equipped to perform artificial respiration and rapid tracheal intubation Accordingly, the drug should not be used by the inexperienced without supervision Myasthenia gravis is an absolute contraindication to its use

Less severe untoward effects are a 30 to 40 mm of mercury fall in blood pressure and a diminution in pulse pressure Unrelieved respiratory depression may raise the blood pressure because of increase in carbon dioxide concentration Bronchial constriction occasionally occurs after the administration of intocostrin Preliminary medication with 3 mg of atropine sulfate subcutaneously is recommended to reduce salivation

When given intravenously, intocostrin is eliminated rapidly, partly by destruction in the liver and partly by renal excretion There is no evidence that the drug produces visceral damage It has been used in patients with impaired liver and kidney function without prolongation of effect

The most extensive use of intocostrin has been with cyclopropane, but it can also be used with avertin nitrous oxide or pentothal Conscious patients have a sense of suffocation when given intocostrin, so that it is not recommended as an adjuvant to regional anesthesia When given intravenously during cyclopropane anesthesia, the maxi

The level of anesthesia on the skin is not a reliable guide More important is the amount of intercostal paralysis and the action of the diaphragm Ordinarily, a patient during spinal anesthesia breathes quietly, using only the diaphragm, even when the intercostal muscles are not paralyzed Observation of intercostal activity must be made during anesthesia by asking the patient to inhale deeply Failure of intercostal activity should be treated at once by oxygen inhalations, and the use of the accessory muscles of respiration should be supplemented by manual compression (about 10 cm of water pressure) of the oxygen breathing bag with each inspiration By observing intercostal paralysis early and instituting this treatment at once, the anesthetist keeps on the alert to initiate artificial respiration the moment diaphragmatic action stops Failure to make these observations early enough and failure to maintain adequate blood pressure account for most of the sudden deaths during spinal anesthesia in good risk patients

The average doses of procaine, pontocaine and nupercaine are as follows

Procaine 1 Operations on legs, perineum, bladder, prostate—75 to 100 mg in 3 cc spinal fluid, third lumbar interspace

2 Inguinal hernia—120 mg in 3 cc spinal fluid, third lumbar interspace

3 Salpingectomy, oophorectomy, ureterolithotomy, pyelotomy, appendectomy—150 mg in 4 cc spinal fluid, third lumbar interspace

4 Suture of perforated ulcer, cholecystostomy, cholecystectomy, splenectomy—200 mg in 4 cc spinal fluid, second lumbar interspace

Because of short duration of action, procaine is usually combined with pontocaine to get longer duration of anesthesia

Procaine plus Pontocaine 1 Operations on legs, perineum, bladder, hips, vagina—50 mg procaine plus 10 mg pontocaine in 3 cc total volume of injected solution, third lumbar interspace

2 Inguinal hernia—100 mg procaine plus 10 mg pontocaine in 3 cc total volume of injected solution, third lumbar interspace

3 Salpingectomy, oophorectomy, ureterolithotomy, pyelotomy, appendectomy—100 mg procaine plus 12 mg pontocaine in 3 cc total volume of injected solution, third lumbar interspace

4 Hysterectomy, nephrectomy, sigmoid resection—100 mg procaine plus 15 mg pontocaine in 3 cc total volume of injected solution third lumbar interspace

5 Suture of perforated ulcer, cholecystectomy, splenectomy, gastro enterostomy—100 mg procaine plus 16 mg pontocaine in 4 cc total volume of injected solution, second lumbar interspace

CHAPTER 47

POSTOPERATIVE CARE

IMMEDIATE CARE

The anesthetized patient should not be transferred from the operating table to a stretcher or from a stretcher to his bed until there are a sufficient number of hands available to do the proper lifting This is best done by lifting the patient on a full drawsheet or blanket For the adult patient of average weight this means that four persons are needed to transfer the patient, one for the legs, one for the head and one for each side This will prevent any undesirable strain on the operative site, as well as injury to the extremities and head The unconscious patient is prone to sprains and dislocations, if improperly handled, particularly in turning

As the patient leaves the operating room, he should be accompanied by the anesthetist, a house officer or a nurse The patient should never be left alone, he demands constant vigilance until he has regained consciousness and is cooperative The aspiration of mucous or vomitus may have serious consequences This demands quick action, for fatal asphyxiation may result in a minute Lower the head and turn it to one side Then use suction, if needed, to clear the throat

The use of an airway minimizes, but does not eliminate, these dangers The airway may be plugged It should be removed when the throat reflexes have been reestablished The patient usually spits out the airway at this time or gags in his attempt to dislodge it

So long as the patient in the immediate postoperative state is unconscious he must be continuously watched to avoid obstruction of the epiglottis by the weight of the relaxed jaw and tongue Keeping the patient's head lowered and to one side avoids this and prevents inhalation of regurgitated gastric contents If there is cyanosis, lift the mandible up and forward A substantial degree of anoxemia is frequently present during anesthesia and postoperatively without clinical evidence of its presence Even slight cyanosis indicates a far greater degree of anoxemia (more than one third desaturation) than is generally realized

mum effect, as measured by respiratory depression, occurs in about five minutes Thereafter the depression of respiration gradually subsides, so that after about twenty five minutes respiration returns to the rate and depth observed before administration of the drug

The dose of intocostrin is 1 to 3 cc (20 to 60 units) intravenously, according to the estimated muscular tone of the patient But a dose of 3 cc in the muscular young male may be inadequate An additional 1 to 2 cc may be necessary for adequate relaxation In the female with poor muscle tone 1 to 2 cc may be sufficient With ether the dose of intocostrin is reduced to 1 to 2 cc because ether itself has some curare like action Additional doses may be given, but because of cumulative action, these are smaller than the first

The relaxation of striated muscle induced by intocostrin has led to its use for the treatment of fractures which resist reduction because of spastic muscles Its value for the control of spastic dis orders and for the prevention of injuries during convulsive therapy is not yet fully demonstrated

and dry gauze, left in body tissues and cavities, may cause bleeding by erosion

Postoperative hemorrhage may be recognized by (1) visible external bleeding, (2) local signs of concealed hemorrhage, (3) systemic signs of blood volume loss Even considerable external bleeding may go unrecognized because it is not looked for Bleeding from a perineal wound sufficient to soak through the mattress may occur before a first postoperative inspection is carried out Subperitoneal, retroperitoneal and intramesenteric accumulations of blood are harder to identify Recognition of reduction in circulating blood volume is not always simple in the early postoperative period because the anesthesia, pressor drugs, morphine, barbiturates, pain, apprehension or other factors may mask the signs and symptoms and influence the pulse and blood pressure Considerable care and clinical judgment may be required to distinguish circulatory effects due to reduced blood volume from those due to neural and pharmacological influences

Postoperative shock in most instances results primarily from uncompensated hemorrhage during operation, aggravated by the effects of anesthesia and surgical manipulation, or from continued bleeding afterward Other primary causes of sudden vascular collapse must be seriously considered, because the therapeutic problem may be quite different from merely one of simple replacement of blood loss For example, (1) *strangulation obstruction of the intestine* may occur early after laparotomy and require not only transfusion but surgical excision of the infarcted bowel and prophylactic chemotherapy, (2) *myocardial infarction* may occur during or after surgery when there has been antecedent coronary arteriosclerosis and a period of hypotension during or after operation which has lasted long enough to induce coronary thrombosis Sudden vascular collapse also may result from (3) *pulmonary embolism* This usually occurs only after the third or fourth postoperative day (4) *Peritonitis* or other fulminating sepsis may produce a rapidly progressive form of shock, even in the absence of fever Obviously, effective treatment of such varying conditions will not be achieved unless one is alert to such developments

GENERAL CONSIDERATIONS

If a patient receiving a transfusion shows the slightest reaction, subjective or objective (nausea, headache, chill, pain in the flank, restlessness, dyspnea), stop the transfusion *at once* and report to the director of the blood bank

See that the patient is turned frequently, at least every three hours, until he can turn himself, that the toes, feet and legs are frequently used in bed, that deep breathing exercises are taken every hour

Use prophylactic chemotherapy (usually penicillin alone) (1) if the wound was heavily contaminated during operation, (2) if there is a pulmonary disorder, e g, atelectasis, emphysema, low vital capacity or susceptibility to pulmonary infection because of old age or bronchiectasis

Maintain fluid and electrolyte balance (See chapter on Fluid and Electrolyte Balance) Every postoperative patient does not require a venoclysis A patient whose water deficiency is slight and who may be expected to take fluids orally in adequate quantity within a few hours does not require this therapy When it is not needed, it is an annoyance to the patient and a burden to the personnel, and may be harmful rather than helpful physiologically

Adults should receive fluids by vein rather than by hypodermoclysis The latter is more uncomfortable and fluid absorption less controllable, but the addition of the enzyme hyaluronidase, which is a spreading factor, to the fluid permits rapid and relatively painless administration When veins are not available, fluid may be given by sternal puncture, but this route can be hazardous and is a last choice Proctoclysis is an inefficient and outmoded procedure

POSTOPERATIVE HEMORRHAGE AND SHOCK

(See chapter on Hemorrhage and Traumatic Shock, p 39)

Patients must be seen in the immediate postoperative stage as often as possible—at least several times each day—because this is the time when critical developments are most likely

Hemorrhage may occur early or late and may be obvious or hidden Early hemorrhage usually derives from vessels not secured or inadequately secured during the surgical procedure Shock during operation increases the likelihood of postoperative bleeding because the procedure may be completed before normal blood pressure is restored and large unligated vessels may therefore, have been overlooked Later hemorrhage results from necrosis or sepsis It is usually arterial in origin and may occur at any time until healing is complete Certain tough and vascular tissues (e g, the uterine cervix) sometimes require such firm suture ligature for hemostasis that secondary bleeding due to necrosis by the constricting ligature may occur as late as seven to fourteen days after operation Hemorrhage from a drained abscess cavity is possible up to the time it becomes lined by granulation tissue Foreign substances, particularly hard rubber

and dry gauze, left in body tissues and cavities, may cause bleeding by erosion

Postoperative hemorrhage may be recognized by (1) visible external bleeding, (2) local signs of concealed hemorrhage, (3) systemic signs of blood volume loss Even considerable external bleeding may go unrecognized because it is not looked for Bleeding from a perineal wound sufficient to soak through the mattress may occur before a first postoperative inspection is carried out Subperitoneal, retroperitoneal and intramesenteric accumulations of blood are harder to identify Recognition of reduction in circulating blood volume is not always simple in the early postoperative period because the anesthesia, pressor drugs, morphine, barbiturates, pain, apprehension or other factors may mask the signs and symptoms and influence the pulse and blood pressure Considerable care and clinical judgment may be required to distinguish circulatory effects due to reduced blood volume from those due to neural and pharmacological influences

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If a patient receiving a transfusion shows the slightest reaction, subjective or objective (nausea, headache, chill, pain in the flank, restlessness, dyspnea), stop the transfusion *at once* and report to the director of the blood bank

Do not judge the patient's postoperative condition from a nurse's report Do not write an order "watch for bleeding" unless the nurse can readily detect it If there is danger of bleeding from any wound, you must accept that responsibility yourself in large degree If blood pressure falls and neosynephrin has been ordered and given with a resulting pressor response, you are not to assume that the hypotension is simply vasomotor instability It may be due to concealed bleeding or to shock from other causes

Frequent pulse and blood pressure observations are valuable, but after a reasonable time they should be discontinued Do not forget that nurses are sometimes unnecessarily overworked

So called *"ether blankets"* are usually unnecessary and generally undesirable because they cause sweating Postoperative pneumonia has little or nothing to do with drafts or exposure

The patient usually lies flat in bed when first returned from the operating room When consciousness returns, a pillow should be provided for greater comfort even if spinal anesthesia was also used When the patient is wide awake, the position giving greatest comfort usually should be permitted This position is with the head, shoulders and chest elevated to a degree which the patient finds most comfortable The "high Fowler's" position does not permit the freedom of mobility which the patient should have The mild Trendelenburg position is unphysiologic and should not be used except when profuse secretions from the trachea and pharynx in the unconscious position require it or for the patient in shock

Vomiting in the immediate postoperative period should not persist after the first twenty four hours If it does, consider omitting or reducing opiates Do not allow such a patient to continue taking fluids by mouth until at least four hours without vomiting have passed Then begin cautiously If vomiting persists, deep breathing may inhibit it Try peppermint water or 10 minims of 1 1000 epinephrine in a little cold water Gastric lavage with a 1 per cent bicarbonate solution will frequently relieve the patient

If the patient can take *food* and retain it without discomfort, allow it from the first postoperative day unless there is a special contraindication The tendency to restrict food and fluid for the first few days when the patient is willing and able to take it is not good practice Food by mouth is not allowed for several days if there is a suture line in the stomach or small intestine, but increasing increments of water are permissible within twenty four hours If the suture is confined to the colon, readily and completely absorbed fluids and food (water, tea coffee clear soup toast, crackers, clear,

slightly sweetened drinks) may be allowed in moderation after forty-eight hours, providing there is no distention

If there is *gastric retention*, stop all fluid and food by mouth until the stomach empties sufficiently The patient's own epigastric discomfort is a good guide, but a more reliable one is the amount of fluid aspirated from a Levin tube several hours after alimentation

There is no justification for a postoperative "routine" in regard to *enemas or laxatives* Enemas are given if there is distention, rectal discomfort or persistent "cramp", otherwise, not before the fourth or fifth day and then only if the patient has used a commode or toilet without success An occasional mild laxative may be used, but it is unnecessary to administer one every evening of every day in which no evacuation has occurred, particularly in ambulatory patients Do not order enemas, if the colon has been sutured, until healing is secure If there is no suture line in the colon, enemas may be ordered after the third postoperative day, if necessary

Debilitated patients may acquire a fecal impaction If rectal discomfort is complained of, do a rectal examination

The most important cause of gaseous distention of the intestine is swallowed air When it is important for wound healing and for other reasons to prevent distention, a Levin tube should be passed in the immediate postoperative period and retained until peristaltic function is restored

A rectal tube or enema is helpful for *mild gaseous distention* The most effective enemas are (1) milk and molasses 100 cc of each, (2) 50 per cent magnesium sulfate glycerin and water (60 cc of each) or (3) turpentine 1 tablespoonful to 2 quarts of water If the enema is not effective and the patient is grossly uncomfortable, eserine or prostigmine may be used, providing it is certain that the distention is not due to obstruction Do not rely on heat to the abdominal wall for the treatment of distention, although minor discomfort from "gas pains" is alleviated by a hot water bag Stupes and poultices are insufficiently rewarding besides being a considerable nuisance to nurse and patient If distention is severe and obstinate start tube drainage and suction (see chapter on Complications)

Ambulatory patients will as a rule, require no opiate or only an occasional dose for *pain* after the first seventy two hours If needed, demerol, 50 mg q 3 h , will usually suffice Do not use morphine for apprehension or restlessness A barbiturate will usually work as well or better than an opiate

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If spinal anesthesia has been given, postoperative *lumbar puncture headache* may occur The pain is felt in the occiput and back of the neck quite commonly, and is characteristically aggravated on sitting up and relieved on lying down Such patients may be helped by caffeine sodium benzoate, ½ gram intravenously, q 4 h , p r n In obstinate cases intrathecal 0 8 per cent saline solution may help

Activation of the Patient After the patient is returned from the operating room, the legs are raised and lowered and gently massaged frequently The patient is asked to take ten deep inspirations every hour except when asleep He should be turned frequently, when possible The adult patient should be out of bed the day after operation, if possible, regardless of age Proceed as follows Elevate the head of bed and after some fifteen minutes let the legs hang over the side of the bed Shoes are put on Then have the patient stand, take a few steps and sit in a chair for as long as he is comfortable Sitting in a chair is not sufficient The patient should now walk in shoes as far as he can without becoming exhausted This routine is repeated several times a day and each day more often Most patients will think it impossible to do this at first, but after tactful encouragement they generally become enthusiastic and cooperative

Contraindications to early ambulation are (1) high fever, (2) severe cardiorespiratory disorders, (3) severe debility, (4) active sepsis, (5) major fracture of a lower extremity, or (6) restrictive apparatus

The principle of early mobilization after operation is based on data showing the deleterious effects of immobilization on physiologic function Thus, nitrogen, calcium, sulfur, phosphorus, sodium and potassium excretion are increased These losses run parallel with evidence of decalcification of bone, loss of muscle mass and muscle strength, deterioration in mechanisms essential for adjustment of the circulation on assuming the erect posture, decreased exercise tolerance and decline in blood volume A positive balance is re established only after a number of weeks of resumed activity

The beneficial results of early mobilization are clinically reflected in the more rapid restitution of normal visceral and somatic function Hesitation to allow activity because of the fear that wound disruption may be precipitated is not justified by experience Clean, well sutured wounds heal at least as satisfactorily in rapidly activated patients as in immobilized ones It is doubtful if the strain upon suture lines produced by this activity is greater than the strain from the effort involved in coughing, getting on a bed pan or changing position in bed Moreover, the suture material used and the manner

of wound closure should be such as to stand the strain involved with a wide margin of safety This is not intended to imply that obviously weak or weakened wounds or wounds already under great strain should be included among those considered safe for the foregoing regimen

If there is *persistent fever* after the third day or *pain in the heels, feet or calves, however trivial,* at any time, examine the legs for deep *phlebitis* If there is phlebitis, the most valuable sign of its presence is pain on thumb pressure deep behind the medial crest of the tibia at the midcalf level Daily examination of the calves is a routine part of postoperative care, even in the absence of pain

If the patient complains of substernal or pleuritic pain, however trivial, after operation, think first of *pulmonary embolism*

Diarrhea in the presence of abdominal sepsis often means pelvic abscess Do a rectal examination

Dressings and Binders Upper abdominal adhesive strips limit respiratory movements and encourage atelectasis Do not apply them transversely across the costal margins Place them obliquely and do not include more than the anterior half of the chest wall Adhesive strips on an abdominal wound dressing are not used for the purpose of supporting sutures and therefore need not be tight Examine the dressing the day after operation The adhesive strips are usually too snug by this time Distention may have developed already Loosen the strips whether the patient complains of tightness or not Do not remove the strips—cut them along the vertical border of the gauze Let the strips gape and reseal without tightening after the patient has taken several deep breaths

When the patient is mobilized, a snug but not tight binder may be used as a splint if he feels the need of one The routine application of a binder in and out of bed is not necessary The patient may be more comfortable without one Binders, moreover, discourage the use of the abdominal muscles and restrict full respiratory activity

Surgical wounds which are expected to heal by first intention should be left alone and not inspected until sutures are to be removed, unless there is reason to believe infection is present or the wound is grossly uncomfortable

MEDICATION

Pain

The treatment of pain should take account of the mechanism responsible for it Spasm of smooth muscle can be relieved by atropine Ergotamine relieves the headache of migraine by constricting

overdistended arteries Analgesics are used to dull sense perception or reaction to sensory impulses, and may be less valuable or effective than drugs which interrupt the mechanism responsible for the pain Among analgesics acetylsalicylic acid, acetophenetidin, etc, raise the threshhold for pain perception Their maximum effect is obtained at an optimum dosage, which, if exceeded, provides no additional benefit A combination of two analgesics does not produce an additive effect, but only the effect of the stronger agent Opiates and alcohol control reaction to pain and raise the threshold for pain perception Relaxation and release from anxiety outlast the effect on the pain threshold A severe pain may mask the perception of another pain Thus in peripheral vascular disease, intense pain in the great toe may be the only complaint yet if this toe is rendered anesthetic, pain in other parts of the foot will be felt If morphine is given and a new pain is experienced during the action of morphine on the old pain, the new pain will be felt as if the patient had had no morphine and the relaxation and anxious free effect is lost Suppression of the pain restores these psychologic effects This may explain why morphine addiction is not easily acquired by patients with sustained intense pain

Headache is chiefly due to traction, displacement, distention or inflammation of cranial vascular structures Supratentorial irritation is felt above the ears, in the anterior half of the head, subtentorial irritation is felt in the occiput

The pain of lumbar puncture headache is due to a fall in pressure at the vertex of the cranium and is abolished by intrathecal saline This pain, as well as the pain of increased intracranial pressure, is also due to traction on vascular structures rather than to the degree of change in brain volume

Brain tumor headache is not proportional to the increase in pressure The headache is located near the tumor in about 50 per cent of cases It is usually the first symptom of posterior fossa tumors and in these it is nearly always in the back of the head In supratentorial tumors it is frequently in the front of the head If headache due to brain tumor is continuous, the location of the tumor at the site of the headache is all the more likely

The headache of fever, like that from histamine, is the result of vascular dilatation and can be relieved by increasing cerebrospinal fluid pressure *Migraine headache* results from changes in amplitude of pulsation in the branches of the external carotid artery and not of the cerebral vessels Ergotamine reduces the amplitude of these pulsations

The headache of hypertension is due to a similar mechanism and is not directly related to the level of blood pressure Compression of the carotid artery relieves this headache as well as that of mi graine

Pain referred from viscera or the skeleton to a cutaneous segment produces hyperalgesia of the skin In certain areas skin and deep tissue innervation do not coincide Thus in the lower aspect of the scapula, the skin is innervated by the seventh dorsal segment, while the muscles and ligaments and bone are innervated by the seventh or eighth cervical segments The cutaneous reference from deep pain usually does not involve the whole segment of reference Abdominal visceral pain is referred anteriorly Ureteral pain is also and only when the stimulus is intense is there a posterior reference (to the flank)

Cardiac pain is characteristically referred to the third to sixth dorsal segments anteriorly and to the first and second dorsal seg ments in the arm, but if intense it may spread to involve areas from the third cervical to the tenth thoracic If the parietal or diaphrag matic pleura is irritated, pain is felt in the corresponding cutaneous areas of reference, but the visceral pleura is insensitive Both peri cardial coats are insensitive except where the parietal pericardium fuses with the diaphragm Irritation of the central tendon of the diaphragm will produce pain reference to the trapezius and supra clavicular area of the neck anteriorly, while irritation of its peripheral muscular portions will be referred to thoracic segments six to twelve

Esophageal pain is commonly felt as "heartburn," which is caused by spasm of the cardiac end of the esophagus This may be due to acid regurgitation Spasm induced reflexly by intestinal obstruc- tion, reverse peristalsis or psychic disturbances may also cause heart burn

Gastric pain is referred to the seventh, eighth and ninth dorsal segments The healthy mucosa is insensitive to strong irritation, but irritation of inflamed gastric mucosa can cause severe pain The same is true of the mucosa of the colon and urinary bladder The pain of peptic ulcer does not occur unless the ulcer is exposed to acid Wash ing out the stomach, emesis or neutralization stops the pain The pain is not induced by muscular activity, spasm or antral distention The difficulty in differential diagnosis of upper abdominal lesions is in part due to the fact that the pancreas, liver and biliary tract have the same segmental innervation

The rectum, bladder trigone, cervix and prostate receive a sacral sensory innervation, but the fundus of the uterus is represented in

the tenth dorsal to the first lumbar segments, the tubes and ovaries in the tenth dorsal, the urinary detrusor and lower colon in the eleventh and twelfth dorsal segments

When a patient describes pain, as he should be allowed to do in his own words, such terms as pricking, burning or itching pain are of cutaneous origin, while dull aching pain is of deep origin Burning pain is also felt in the nose and upper gastro intestinal tract

The time factor is also important Continuous abdominal pain is likely to signify inflammation or continued stretching (viz , liver or splenic capsule, pancreatitis, peritonitis, intestinal distention), while crescendo like intermittent pains suggest a spastic phenomenon resulting from obstruction of a viscus The pain of migraine is continuous and pulsatile, the pain of tic douloureux is stabbing and of short duration

Painful joints hurt most in cold damp weather *Spinal root pain* is elicited or made worse by an increase in venous distention of the intraspinal veins This occurs upon straining, coughing or sneezing

The intensity of pain is a subjective experience that is not easy to convey It is a combination of pain perception and reaction to pain, the latter depends on the patient's tolerance, which is extremely variable but can be gauged by reaction to pressure on known sensitive areas like the supra orbital nerve and the styloid process or by pinching the biceps

If morphine is withheld until the patient experiences severe pain, the effectiveness of morphine is less than if it is given in advance of experiencing the pain

The fear of excessive use of opiates which might lead to addiction results too often in too sparing a use of them when the intensity of pain justifies greater liberality Thus, if morphine every three to four hours, as needed, is prescribed but is not effective in abolishing intense pain, there is no good reason why it may not be given more frequently or in a larger dose or by a quicker route—even intravenously, if necessary—with due regard to its effect on respiration, intestinal function etc The range between effective analgesia and toxic effect is sufficiently wide to permit some liberality in its use when the occasion demands

The favorable effect of morphine on pain is counterbalanced by its effect on the respiratory tract Depth and rate of respiration fall in spite of an increase in alveolar carbon dioxide If secretions are present in the airway, the protective value of the cough is diminished or lost The value of opiates in pulmonary and cardiac complica

tions of surgery is largely confined to relief of dyspnea, but the simultaneous adverse effects require the exercise of nice judgment as to dosage If a useless (nonproductive) cough is annoying, codeine is the preferred drug, because it depresses respiration less than morphine and is less constipating

Severe pain in viscera requires opiates, but for pain in muscles, joints and other structures, the salicylates are usually adequate

When opiates are contraindicated, i e , when respiratory exchange must not be depressed, or because of hypersensitivity (itching, severe nausea, etc), other opiates may be tried for their special advantages Thus, papaverine will affect smooth muscle but not the nervous system, while demerol will relieve pain, and nausea will be minimized

The more severe the pain, the more opiate can be tolerated Thus, in severe coronary thrombosis, two to four times as much morphine as usual can be given without a pronounced effect on respiration However, if pain suddenly ceases, such large doses may then turn out to be excessively depressant and conceal other vital signs

The cause of pain should be known before morphine is given Hence, in acute abdominal disorders, particularly, withhold the drug until the diagnosis is made Sometimes morphine used with nice discrimination may eliminate spasticity of cortical origin and permit eliciting true reflex spasm

There is no use in withholding adequate drug therapy for pain from a hopeless malignancy or other inevitably fatal disease If nonnarcotic sedatives no longer work, try a slow intravenous drip of alcohol (5 per cent) in saline or dextrose solution After the value of these has been exhausted, use demerol or other opiates, increasing the dose as tolerance requires If addiction develops in these circumstances, it is no calamity * The tranquillity that comes with relief of pain from the use of alcohol to the point of mild euphoria or from narcotics is a blessing for the patient and family

If none of these measures controls pain, a nerve blocking procedure may be needed This may be achieved by defunctioning sensory nerves Thus, in thromboangiitis obliterans of the lower extremity, section or alcohol injection of the sural, internal saphenous, anterior and posterior tibial and the superficial peroneal nerves will be required to anesthetize the foot Division of the superficial cervical plexus at its emergence from the sternocleidomastoid is helpful for

* 1 6 dimenthylamino 4 4 diphenyl 5 methyl 3 hexanone HCl (1 iso methadon) and other compounds are newer drugs which are said to have greater potency and less habit forming qualities than opiates and to be free of one or another undesirable side effect of morphine More clinical evaluation is required before acceptance of such claims is possible

incurable pain in its field of distribution Section of sensory nerve roots may be required Visceral abdominal pain of unknown etiology is occasionally relieved by splanchnicectomy, which is a sympathetic de afferentation procedure The same principle is involved in sympathectomy for angina pectoris Vagotomy relieves the pain of peptic ulcer, not by de afferentation, but by blocking psychic secretion of acid The pain from neoplasms of the apex of the lung (Pancoast tumor) can be relieved by posterior root section If the route of the pain impulses is not easily defined, it may be necessary to do a cordotomy, or for pain in the head and neck a medullary tractotomy Lobotomy does not abolish pain perception, but pain thereafter does not trouble the patient subjectively

Insomnia and Restlessness

If sleeplessness is due to severe pain or cough, use opiates Delirium, mania and excitatory states caused by thyrotoxicosis, encephalopathies and similar disorders are better treated by other sedatives If the patient is restless and apprehensive, as from internal hemorrhage, threatened abortion or congestive heart failure, morphine is very useful If the patient is in shock, morphine by the subcutaneous or oral route will not be effective, owing to defective absorption If repeated doses are given in this situation, severe cortical depression will set in as circulatory recovery improves absorption Do not use morphine as an anticonvulsant, because its central depressant action results in increase in spinal cord excitability

It is important to realize that sleeplessness is not always due to physical discomfort Fears and anxieties from the illness itself or from psychological factors antedating but revived by the illness, may be responsible for sleeplessness, a whining attitude, lack of cooperation or general fussiness If the physician is capable of instilling confidence in the patient, the intensity of such symptoms will be minimized and the need of drugs reduced or avoided

Lack of sympathy, indifference to the patient's complaints, even when they are trivial neglect to reassure him concerning his fears, insufficient care to prepare the patient's mind for what is in store and what will be done to establish maximum comfort—all these contribute to an untoward psychological response to the trauma of surgery The surgeon who takes the trouble to explain what he intends to do and why it is necessary to do it, who tells the patient in advance when and where and approximately how long he may feel pain or endure discomfort, will not only avoid difficulties for himself, but will obtain maximum cooperation and a happier and more

grateful patient The most critical moment for the patient is the day before and the morning of operation, when the way he will be handled, anesthetized, etc , should be explained to him in detail so as to allay the fear from uncertainty and surprise Thus the patient will be led to feel that he can put his full trust in the surgeon and will usually acquire a peaceful frame of mind, which will contribute to a smoother postoperative course and a more rapid recovery

When the surgeon betrays that he is beset by doubts and hesitations, however legitimate the basis for them may be, sleeplessness is more likely to persist and pain, if present, to be exaggerated It is, therefore, incumbent upon the surgeon to regard his patient before, after and even while he is operating upon him not simply as the victim of an organic disease, but as a whole personality The relationship between himself and the patient is a continuous one from the beginning to the end of the illness and the emotional factors in the entire period of contact need careful and considerate attention until recovery is complete

These remarks are as true for children as for adults Not a little of the resistance of adults to the acceptance of surgical therapy derives from inconsiderate handling when they were children (See Psychiatric Considerations in Surgery)

Bladder Care
(see chapter on Urologic Disorders)

About 10 per cent of postoperative patients develop some degree of *urinary retention* The administration of intravenous fluids during and after a surgical procedure may aggravate the situation by overdistending the bladder before the patient's return of bladder sensation Surgery of the anterior vaginal wall and pelvic organs is apt to disturb the nerve supply of the bladder Some patients cannot void lying down or in the presence of other people, because of psychogenic spasm of the sphincter The painful wound may interfere with muscular contraction necessary for complete emptying of the bladder Motion gives patients confidence in their wound and in their ability to take some pain The patient who moves about, therefore, is apt to overcome this cause of retention

Whenever possible, catheterization of the male patient is to be avoided There is less danger in permitting the male patient to go for twelve hours or longer, if his discomfort is not too great, than there is in producing infection Because of the danger of infection, every other measure should be tried first—heat over the lower abdomen, the sound of running water, the sitting or standing po

sition, a 2 ounce rectal instillation of glycerin or a small enema (magnesium sulfate, 1 ounce, glycerin, 2 ounces, water, 3 ounces), if the nature of the operation permits If the bladder is so distended as to be palpable above the symphysis pubis, it should be emptied Otherwise, tone will be lost and frequent catheterizations will be needed

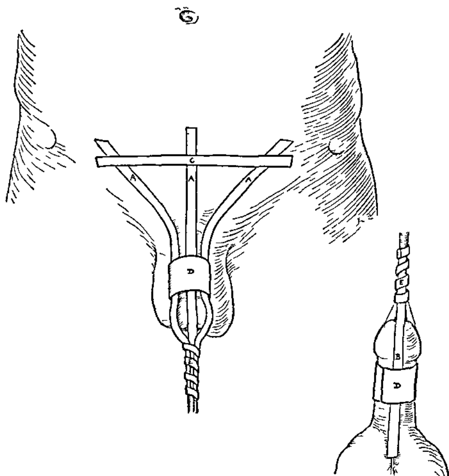


Fig 33 Narrow adhesive strips approximately 1/4 inch in width are used Three of these strips which begin in the suprapubic region are continued onto the penis and catheter (A) A shorter strip of the same width begins on the raphe of the scrotum and runs on the undersurface of the penis to the catheter (B) The transverse suprapubic strip (C) acts as an effective anchor to supplement the circular strip (D) around the penis A small circular strip (E) secures the adhesive to the catheter (Mason and Zintel Preoperative and Postoperative Treatment)

If retention persists for more than several days of intermittent catheterization, constant drainage for five days is employed When the patient becomes ambulatory, the catheter is removed, but a test for residual after voiding is done If more than 2 ounces is found, constant drainage is reinstituted (Fig 33) Constant drainage is best accompanied by irrigations twice a day with normal saline solution Because both an atonic bladder and intermittent catheterization pre

dispose to infection, prophylactic chemotherapy, preferably 1 gram of sulfamethazine, q i d, is required, until residual is abolished If the bladder has become atonic and does not empty even with forced contraction of the abdominal muscles, restoration of bladder tone may be achieved by parasympathomimetic drugs A dose of 0 05 mg of pitressin intravenously may work, but it must be used with caution because it may produce pulmonary edema "Furmethide" or "doryl" (see tables on Special and Specific Medication) may also be used "Furmethide" is sometimes dramatically effective, but a first hypo dermic injection is likely to produce other distressing symptoms, such as severe sweating and severe abdominal cramps Thereafter, it may be given frequently without the occurrence of these side effects It may also be effective if taken orally

Except in unusual circumstances the male patient should be catheterized by a house officer or under his supervision

In women the dangers of catheterization are considerably less than in men After vaginal operations many surgeons prefer to insert an indwelling catheter for three to four days If the urethra has been involved in the procedure, this is frequently necessary If not, cathe terization proves unnecessary in many cases

Now and then prostatic obstruction manifests itself for the first time after an operation elsewhere It may be difficult to determine this as the cause, if rectal examination does not reveal it, without resorting to urologic diagnostic procedures, i e, catheterization, cystoscopy, radiographic technic

Frequency of urination requires measuring bladder residual, cul ture of the urine and sediment examination

CHAPTER 48

CARE OF WOUNDS

Closed clean surgical wounds are capable of penetration by pathogenic organisms deposited along the suture line up to the fifth or sixth postoperative day Hence a closed surgical wound should not be disturbed until it is necessary to remove sutures, unless there is an unusual amount of pain in the incision or a constitutional sign or symptom raises the suspicion of infection in the wound If the wound remains clean and is healing by primary intention, skin sutures should be removed as early as possible, consistent with firm agglutination of the skin edges once the sutures are out The time varies with the location as follows scalp—third to fourth day, face—fourth to fifth day, eyelids—second day, horizontal neck incisions—second day, vertical neck incisions—fourth to fifth day, chest and abdomen—fifth to sixth day, extremities—sixth day, plantar surface of foot—tenth day Mass ligatures and stay sutures should not be removed before the eleventh to the fourteenth days

Since the rate of wound healing depends upon a number of other factors also—age, nutritional state, local blood supply, systemic disease, amount of substance removed, local stresses, etc —these must be taken into account in deciding upon the optimal time for suture removal The more favorable the condition for healing, the earlier may sutures be removed and the less will be the scarring and infection produced by the sutures Abnormal wound strain and poor healing may require the retention of sutures in spite of cutting, scarring and infection When, however, tension from infection or tightness of sutures produces necrosis and threatens extensive breakdown of the wound, the removal of sutures minimizes the ultimate loss of substance and the intensity of infection In abdominal incisions the possibility of evisceration makes the decision as to removal of such sutures difficult

In removing sutures, grasp one end of the exposed loop in forceps without pulling upon it, gently depress the skin with the scissors tip until a portion of the buried loop is exposed, cut the exposed buried loop at the skin level and draw out the suture

Antiseptics

Antiseptics are useful chiefly where aseptic preparation of a field is required Tincture of zephiran is satisfactory for this purpose, but the aqueous preparation is used on areas where alcohol will cause pain (perineum, scrotum, abraded or denuded skin, eyelids, external auditory meatus, etc)

The application of all antiseptics which act by protein precipitation to an unhealed surface is not only unnecessary, but often harmful, since they injure healing tissues They do not make a clean wound cleaner, assist in the control of infection or in the formation of granulation tissue in clean or infected wounds Nonirritating substances, such as azochloramid and peroxide, have certain special indications, such as for removal of slough, deodorization, and the like

Skin which is sensitive to vigorous scrubbing with soap and water, e g , the perineum, vagina, umbilicus, can be prepared by a two minute mild scrub with an emulsion of "*p*H isoderm," followed by aqueous zephiran If the emulsion contains "G 11" (2, 2′ dihydroxy 3, 5, 6 3′, 5′ 6 hexachloro diphenyl methane), repeated application will remove virtually all bacteria This preparation gives promise of surpassing nearly all other methods of preparing the skin of the patient and the surgeon's hands for operation

Dressings

Dressings serve a variety of purposes (1) to prevent contamination of the wound, (2) to splint or immobilize the wound, (3) to absorb discharge, (4) to stabilize drains or attached instruments, (5) to protect exposed tissues The manner of application may vary according to circumstances for instance, corselets are preferable so as to permit frequent local applications or changes of dressing The dressing must be applied so as to stay put, be comfortable and be neat A badly applied dressing may do harm, as when the adhesive of an abdominal dressing restricts costal margins or does not allow for increasing distention

Dressings are changed for a specific purpose, and not merely because a given period of time has elapsed That purpose may be the removal of sutures, the inspection of the wound because of a suspicion of fluid accumulation, sepsis or separation, the replacement of uncomfortable or soiled dressings, the reapplication of a dressing which has slipped Purposeless changes of dressings result in unnecessary discomfort, contamination and interference with wound healing

General procedure Do not do dressings if you have a septic hand, however trivial, or an upper respiratory infection

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often followed by increased fibrosis, may result The fluid should be aspirated or evacuated aseptically and a comfortable pressure dressing applied, if needed A culture of the fluid should be made If the fluid is purulent, a soft rubber drain or a strip of petrolatum gauze should be inserted

Hematomas in wounds are painful, cause some fever, tenderness and discoloration Most will absorb spontaneously A large extravasation of blood may require evacuation and packing, but secondary infection frequently follows

Wound separation is usually due to nutritional deficiencies, wound infection or undue stress Premature removal of sutures may be responsible So may defective surgical technic Correct operative suture should observe the following principles Use interrupted sutures tied so as not to constrict the circulation of the tissue in the loop Sutures should be a trifle loose to allow for postoperative swelling If the wound has been grossly contaminated, tight closure will lock infection in and result in cutting through of sutures, with far greater damage resulting than if the delayed closure technic is utilized For closure of laparotomy wounds the use of mass sutures of fine wire or heavy silk in addition to layer suture is desirable (Transverse abdominal incisions are less likely to rupture than vertical ones)

Wound separation may be partial or complete, gradual or abrupt The first evidence of its presence may be an awareness by the patient that something has loosened or given way A patient's statement to this effect should be given credence A more usual initial sign is the discharge of serosanguinous fluid from the wound, which should lead to an immediate inspection A sterile supportive dressing is applied

If a minor wound disrupts, coapt the edges with sterile adhesive and allow it to heal by second intention If a major one disrupts, immediate suture may be required

Disruption of abdominal wounds is a serious postoperative complication Persistent cough, hiccough or extreme intestinal distention are important contributing factors, in addition to those mentioned

Postoperative hernia is a common sequel of widespread infection of an abdominal incision It is less common after secondary suture of a wound rupture Occasionally, clean wounds which have been under prolonged strain from cough or severe distention after operation, but which have nevertheless apparently healed well, will develop a diastasis that becomes evident weeks or months later This is especially true of wounds that have been drained or through which a colostomy is made, or in fat people It is likely that defective suturing may also be responsible in some cases But unrecognized nu

Dressings should inflict a minimum of discomfort—psychological and physical Tact and gentleness will minimize the anxiety which arises from the anticipation of painful dressings and from the sight of instruments, tubes, drains and stained gauze Preliminary seda tion is sometimes necessary and general anesthesia will be required on rare occasions

Bedding is folded back neatly to the lower or upper edge of the wound Wounds are exposed with due consideration for the patient's modesty The removal of the previous dressing is done gently When a dressing is covered by adhesive strips, the latter are cut free along the gauze border, leaving the original adhesive attached to the skin and reapplying fresh adhesive over the old If this must be done many times substitute a corselet (Montgomery type)

Adhesive should be removed with care and gentleness It is as sumed that the skin beneath the adhesive is shaven and that tinc ture of benzoin is applied to minimize skin irritation The removal of adhesive is facilitated by the use of organic solvents such as ether, acetone or benzene, but these are painful on irritated skin Carbon tetrachloride is an undesirable drug in general Use preferably a suitable vegetable oil

A primary prerequisite in dressing a wound is the avoidance of contamination The minimum requirements are clean (freshly washed) hands, bare forearms, sterile instruments and dressings laid out upon a sterile towel neatly placed near the wound edge The hands should never touch an unhealed wound Especially suscep tible wounds (open cranial wounds) should be further protected by the use of a face mask and sterile gloves Highly susceptible wounds can also be infected by air borne pathogenic bacteria, which are most numerous in the air immediately after beds are made (The discharge of bacteria into the air by sweeping is minimized by the use of wet mops instead of brooms) Occasionally such wounds should be dressed in the operating room

When a group of dressings is to be done, the clean wounds should be treated before those which are infected The hands should be washed after each dressing Gloves must be worn when virulent in fections are treated to avoid carrying the organisms to other patients The instruments from such wounds are segregated for separate sterilization

Foreign bodies, such as tubes and drains must be anchored to the body surface or to the dressing so as not to retract out of sight

Fluid Accumulation Pockets of serum or blood in a wound retard healing by preventing normal coaptation of tissues Infection,

suppuration is determined by finding the point of maximum tenderness Be gentle in doing so and use for this purpose the tip of a forceps or a gloved finger If such a well defined point of tenderness exists, remove one or two sutures and insert a fine sterile probe after cleansing the wound surface with an antiseptic solution

Indiscriminate and rough probing of wounds is a frequent source of secondary infection of clean wounds and is to be condemned If a diffuse cellulitis is present, chemotherapy is started and if heat for localization is desired, the wound is covered with petrolatum gauze and warm moist saline compresses applied If purulent material is released, the opening is gently spread by a hemostat and a drain inserted to provide free drainage

If there is extensive suppuration, the entire area is uncovered by spreading the wound edges gently with the blades of a hemostat or by incision Secondary incisions may be required Complete unroofing and light packing afford the best opportunity for rapid healing Inadequate drainage promotes pocketing, extension and chronicity of the infection The infectious organisms must be identified by culture Local antibacterial measures appropriate to the specific organisms may be applied in association with systemic chemotherapy, but as a rule the latter alone is sufficient (see below)

If sepsis is not apparent, even though a severe infection seems to be present, the deeper layers of the wound should be suspected If virulent anaerobic organisms have infected the depths of the incision, the patient will be very sick, the pain and tenderness will be especially severe Massive chemotherapy and prompt free drainage with counter incisions, if necessary, are imperative Otherwise, the sepsis may spread widely along fascial planes In mixed infection the infected and sloughing fascia may have a distinctive foul odor, readily appreciated by experienced observers

Wound sepsis is considered mild in the case of a small area of induration, seratoma, hematoma or stitch abscess Isolated small areas of induration may appear in the subcutaneous tissues of a wound from excessive foreign body reaction to large catgut knots These are tender but disappear in time If a collection of serum does not absorb spontaneously, it may be aspirated Occasionally, stitch abscesses occur around individual sutures Pain, tenderness, localized induration will be found along the stitch tract The chart may show slight fever Removal of the infected stitch and a petrolatum gauze dressing is usually all that is necessary

When a wound, in which buried silk, cotton or nylon sutures have been used, becomes infected, a discharging sinus often results follow-

tritional deficiency, resulting in a weak scar, is probably also a not inconsiderable factor in the etiology of some cases of postoperative hernia

WOUND SEPSIS

To a large degree, the incidence of wound complications reflects the quality of the surgical performance Failure to observe the principles of surgical technic is most often responsible for wound infection Sharp dissection, gentle retraction, accurate hemostasis, avoidance of undermining which devitalizes tissue and produces dead space, the use of fine suture material tied so as not to strangulate large masses of tissue, and scrupulous care to avoid contamination are the requisites for proper wound healing

Organisms are normally found in the deeper layers of the skin, so that perfect decontamination is hardly possible Though contamination from the skin is an important source of infection, the tissues are capable of handling some contamination, but if dead tissue, dead space and the collection of serum occur, infection is likely to result

The tissues of the abdominal wall, especially the subcutaneous fat, are more vulnerable to infection than is the peritoneum, which has remarkable resistance to infection Abdominal wall infection is frequently due to ischemic necrosis resulting from sutures which are too tight or fail to allow for postoperative swelling Contamination from an infected peritoneal cavity or from the gastro intestinal tract should be minimized by appropriate protection of wound edges during operation Infection should not necessarily result because contamination has occured The consequences of severe contamination make it necessary, if dangerous sepsis is to be avoided, to leave a wound which one knows is heavily contaminated, unsutured, except for the peritoneum, packed with gauze, and with a few widely spaced untied mass sutures placed for subsequent closure

The clinical chart will frequently reveal evidence of wound infection before local signs are present Fever above 38 3° C after forty eight hours from the day of operation should suggest wound sepsis Undue pain in the incision, especially on motion, coughing or turning, also suggests it The wound should then be inspected If sutures are too tight and are cutting through, they should be removed Redness and swelling are obvious when the skin and subcutaneous tissues are involved but the recognition of deeper wound infection is often difficult and depends upon an evaluation of the pain, tenderness and induration The accuracy with which deep sepsis is identified is considerably increased by experience Localization of

tract by gentle exploration with a curved or straight forceps or, if necessary, by x ray visualization

Heat Therapy

Heat therapy to assist in localization is now much less frequently employed than formerly, because in most patients chemotherapy performs this function far more effectively However, when heat is to be used for this purpose it is wise to bear in mind certain practical matters The types of heat therapy available are the dry and wet forms—electric light, a heating pad, a flaxseed poultice, a hot soak or a hot wet dressing The first two seldom furnish sufficient heat for the purpose, and the third, fourth and fifth, if properly prepared, are a considerable burden to nurses The poultice and the hot wet dressing (unless insulated with great care) have the further disadvantage of cooling off too rapidly Since the proper use of chemotherapy and effective immobilization will nearly always achieve the objective of localization, heat therapy for the control of sepsis, even when cor rectly employed, is becoming less and less popular If heat therapy is used, it should be stopped as soon as localization has occurred There after it is harmful since it encourages congestion at a time when reso lution is the desirable objective

Refrigeration Therapy

Cold inhibits pain, infection, toxic absorption and tissue devitali zation

When the toxemia from infection of an extremity is severe, the application of ice packs for twenty four hours or longer will reduce or arrest the absorption of toxins and control the local process so that subsequent definitive surgery, such as amputation or drainage, can be performed with the patient in much better clinical condition Blood less limbs requiring amputation, which cannot be performed because of the immediate surgical risk, can be preserved for many days by such refrigeration so as to permit safer surgery later and perhaps at a lower level if, in the meantime, a better collateral circulation has developed This might also be tried for traumatically severed tissues such as parts of a finger, hand or nose

Traumatic Wounds

Traumatic wounds are frequently mismanaged The surgeon's primary obligation in the handling of trauma is that he must avoid inflicting further damage by unwise procedures After controlling gross bleeding, usually by direct pressure over the wound with sterile

ing drainage of the resulting abscess The cavity containing the suture material will persist for weeks or months, until spontaneous discharge or surgical removal of the sutures is achieved Healing will then proceed promptly

The local application of penicillin, tyrothricin or bacitracin to infected wounds which are relatively isolated from the circulation may be useful for organisms which are sensitive to these agents But if the organism is sensitive to an antibiotic which can be given parenterally, and if the wound is not isolated from the circulation, parenteral chemotherapy is preferable As a rule, the primary aim of local therapy, which is to encourage the localization of infection, is best met by immobilization, protection, and by heat therapy where indicated

Drains

The choice of drainage material to be introduced requires careful consideration Penrose tubing slips out easily, petrolatum gauze somewhat less easily and dry gauze stays put best of all, but it is more traumatizing A piece of catheter tubing, if carefully anchored, is the most desirable

When a drain has been placed, dressings are changed as the amount of discharge and the patient's comfort require If this is every day or oftener, a convenient type of dressing is a pair of wide adhesive strips with hooks and eyes, or holes for tapes which can be tied The drain should not be disturbed unless it appears to be obstructing drainage, in which case it should be gently twisted with a hemostat and slightly dislodged

A drain is removed when it has served its purpose There is no rule as to the time when this should be done Consider the purpose of the drain If it is intended only as a vent for blood or serum, it should be withdrawn when such fluids no longer escape from the wound If it is placed as a vent for established infection, it must remain until the exudate stops entirely or is a relatively sterile serous exudate Its removal is started by twisting it loose while still in place

Drains are withdrawn gently and in stages, and if there is much pain, one should stop and consider the need for anesthesia Gauze drains are especially likely to cause pain They may be moistened with peroxide to facilitate dislodgment If more prolonged drainage seems necessary after the drain has been removed, a small catheter may be led into the drainage tract and strapped into position with flamed adhesive for as long a period as seems necessary Do not use force in introducing a drain Find the direction of the drainage

CHAPTER 49

COMPLICATIONS

Acute Gastric Dilatation

In some instances this is due to technical defects of operation, producing mechanical block In others no mechanical block is present and the dilatation is attributed to gastric atony It occurs occasionally after upper abdominal operations for reasons unknown, but in some cases it results from excessive swallowing of air or from duodenal spasm It also occurs in peritonitis Its immediate recognition is essential because the loss of body fluids into the stomach may be so rapid as to produce shock from dehydration Vomiting may be profuse or absent There is epigastric distress of varying degree Percussion will outline the shape of a distended stomach and will be tympanitic if distention is due to swallowed air or flat if due to fluids The outline of the stomach will be limited largely to the left side Prevention and treatment are the same decompression by an inlying Levin tube and suction, which is continued until there is no residue Fluids are then allowed sparingly, with the tube clamped, and if they get through the pylorus, they are increased and the tube is withdrawn Parenteral fluids are given to restore water and electrolyte deficiency

Bedsores

Bedsores result from pressure necrosis in debilitated or malnourished patients who lie immobile in a given position for a long time The same result may follow insufficient padding under splints or traction apparatus The common bedsore over the sacrum is readily infected by urine or feces A slough forms, exposing tissues to infection, with undermining to a variable depth Healing, even in a rapidly improving patient, is a matter of weeks or months and some patients succumb to it The obvious fact is that prophylaxis by frequent turning and cleansing is a vital necessity in very sick patients The skin must be kept dry and clean, the sheets must be without wrinkles and an air ring or proper padding used to distribute the pressure A pressure sore over the sacrum or elsewhere, if not infected, can be

gauze pad or towel, cleansing is performed If this cannot be done without pain, a local or general anesthetic is required The cleansing is done by soap and water in sufficient amount and with enough mechanical energy to remove visible dirt The skin surrounding the wound is treated first in this way Solvents such as acetone or ether may be required to remove grease and other substances This is followed by the application of an antiseptic to the skin, but the *antiseptic is not applied to the wound* After this preparation the wound is cleansed with soap and water, then irrigated with saline solution, if necessary, until it looks clean A good method of cleansing and disinfecting greasy and grimy skin in the region of a traumatic wound is by the application of lime paste An excellent method of doing the same is by the use of the class of detergents known as sulfatates, which contain a penetrating agent in a detergent base, i e, a sulfated alcohol or aliphatic ester added to sulfonated petroleum Injured tissues are trimmed down to healthy levels, vessels tied and the layers sutured or left open as circumstances indicate Prophylaxis against infection, if anticipated, is not achieved by relying upon locally applied sulfonamides or antibiotics Parenteral chemotherapy is more effective, but should not be used indiscriminately Proper wound care in nearly all instances will dispense with the need for such prophylaxis

Whether a wound is traumatic or surgical, septic or clean, *splinting* is a basic principle in therapy Immobilization reduces bacterial dissemination and prevents the pain due to motion Splints should be used even for minor trauma and should be large enough to control motion effectively For example, in finger injuries a splint from the finger tips to the elbow may be more effective than a finger splint A sling in addition to the splint is still better

When large bowel distention contributes to the general distention, the rectal tube or enemas (100 cc each of milk and molasses or 15 cc turpentine in 2000 cc of water) will provide some relief Enemas occasionally stimulate forward peristalsis of the small gut also Al



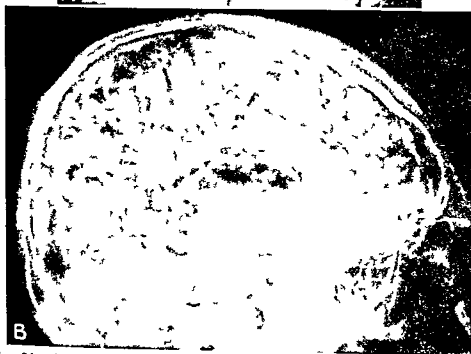


Fig 34 A anteroposterior encephalogram before inhalation of oxygen was used B lateral encephalogram before inhalation of oxygen was used (Schwab Fine and Mixter Arch Neur & Psych Vol 37)

though there is some question as to the value of heat to the abdominal wall, it often provides comfort

In children there frequently is considerable difficulty in passing a tube or keeping it down once it is passed If the child resists unduly

excised with primary healing in a young adult, if the general condition is good enough to warrant the effort

Gaseous Distention of the Intestine

Gaseous distention of the intestine of nonobstructive origin may complicate any type of major surgery It also occurs in nonsurgical disorders—patients very ill with pneumonia or acute cardiac disease or after acute trauma to the spine or retroperitoneal tissues Most of the gas is derived from swallowed air, since over 70 per cent of the gas usually is nitrogen Some of this nitrogen diffuses into the bowel from the blood If the ileus happens to occur when the gut is loaded with food, or if food is swallowed in spite of the distention, other gases derived from food, such as hydrogen, methane and volatile tertiary amines, may constitute a substantial fraction of the gas volume The diagnosis is obvious from the abdominal protuberance and tympanitic percussion Cramps or colic suggest mechanical block Functional ileus produces no pain or only mild fleeting cramps, but there may be considerable distress If mechanical ileus is feared, a scout film of the abdomen is useful to delineate the distribution of the gas in different parts of the gut

The x ray interpretation of gaseous distention is not always simple The particular importance of the scout film lies in its capacity frequently to distinguish functional ileus from mechanical obstruction Various parts of the colon are as a rule readily recognized There is, however, occasional difficulty in deciding which part of the colon is involved For example, in volvulus of the sigmoid, the distention of the strangulated loop may be so massive as to obscure the usual orienting landmarks Occasionally too, the distention of the small intestine may be so great as to simulate distention of the colon The radiologist's experience in detecting haustral markings and valvulae conniventes in these circumstances is of special value

Treatment If distention is severe pass a Levin tube to see if there is gastric retention If there is withhold all food and fluid by mouth If there is not, leave the tube in place so that all air subsequently swallowed will be regurgitated via the tube After an interval of some hours, allow cautiously only such foods or fluids as do not produce gas These are water tea coffee, diluted strained orange juice or clear soup If these are tolerated and the distention is mild or subsiding remove the tube and allow cooked cereal (with a minimum of milk), lean meat, chicken or fish toast, crackers, jello This is a useful diet to avoid the distention due to gases generated by putrefaction or fermentation of foods

raphy and in mediastinal emphysema It can often be achieved by breathing 95 to 100 per cent oxygen until the gases are largely ab sorbed

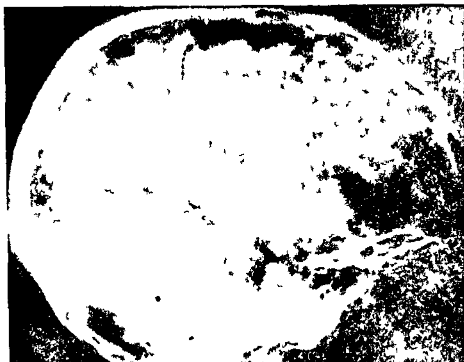


Fig 36 Lateral encephalogram in control case after three hours without oxygen (Schwab Fine and Mixter Arch Neur & Psych Vol 37)



Fig 37 Lateral encephalogram in control case forty eight hours later showing some air still present (Schwab Fine and Mixter Arch Neur & Psych Vol 37)

the tube may have to be abandoned and 95 to 100 per cent oxygen ınhalatıon may be of value

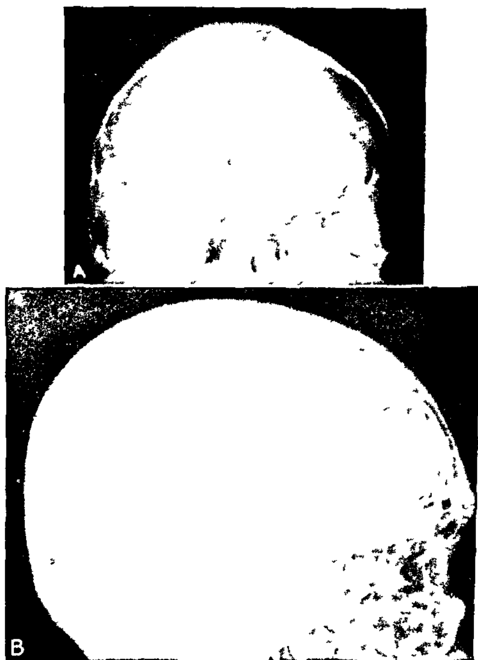


Fig 35 A anteroposterior encephalogram ın same case as ın Fig 34A after ınhala tıon of 95 per cent oxygen for three hours B lateral encephalogram ın same case as ın Fig 34B after ınhalatıon of 95 per cent oxygen for three hours (Schwab Fıne and Mıx ter Arch Neur & Psych Vol 37)

The *absorptıon of gases* from tıssues ıs not only desırable, but may be an urgent necessıty Thıs ıs the case not only ın severe dıs tentıon of the small ıntestıne, but ın aır embolısm, after encephalog

the tube to remain longer than necessary carries two hazards (1) the unnecessary and dangerous depletion of fluid and electrolytes from the gut, (2) the possible ulceration and consequent hemorrhage from a "pressure sore" in the pharynx or esophagus These hazards must be taken so long as obstruction and distention are unrelieved If the tube is used prophylactically, e g , to protect an intestinal suture line, the tube should come out as soon as restoration of peristaltic function and patency of the lumen at the suture line is definitely established Patients who complain of throat irritation from the tube can obtain partial relief from lozenges containing pontocaine, which are available Do not instill mineral oil into the pharynx for relief Aspiration of this oil into the lungs may occur and if so, will damage the pulmonary parenchyma Coiling and even knotting of the tube in the stomach or intestine may result from too much slack Its re moval in the knotted state may be difficult and even hazardous Frequent roentgenographic checking is wise

The Action of Morphine and Atropine Morphine lessens gastric motility, increases muscle tone of the duodenum and small intestine, and abolishes propulsion waves Not only is transport inhibited, but the increased intestinal tone may reverse peristalsis and so cause nausea After some thirty minutes intestinal tone is depressed and transport is abolished for the opposite reason The action of morphine on the colon is similar, except that increase in tone lasts two to three hours These effects plus increase in tone of sphincters, the suppression of biliary and pancreatic secretion, and the central depressant action on sensation result in constipation The tonal rise makes it difficult to intubate patients under morphine

Atropine depresses all phases of intestinal activity The effect is produced in about thirty minutes and lasts one to two hours It may be used with morphine Syntropan or novatropine are said to be superior to atropine because they are said to lack some of the undesir able side effects of atropine This is doubtful

The acceleration of transport is achieved by prostigmine methyl sulfate This drug, by inhibiting cholinesterase, increases tone and propulsive waves within thirty minutes It is given in travenously (0 5 mg) every thirty minutes to one hour until dis tention is relieved or until salivation, flushing or nausea appears Pitressin (1 cc) may be tried, but not in older people, because it causes coronary constriction Ergotamine so potentiates prostig mine that 1/4 mg of each is effective The bromide salt of prostig mine if given by mouth works after two to four hours Do not use these drugs until you are certain there is no mechanical obstruction

The mechanism of action of oxygen is as follows When any gas enters a tissue space or viscus, all the gases in physical solution in the blood or in the tissues surrounding the space affected immediately diffuse into this space, until the partial pressure of each gas becomes the same in the gas bubble as in the surrounding medium Since the partial pressure of nitrogen is over 70 per cent of the total atmospheric pressure in the blood as well as in the inhaled air, the gas bubble, whatever its constituents may have been at the beginning, soon consists largely of nitrogen To get rid of this nitrogen is the goal of therapy This can be achieved by reducing the partial pressure of nitrogen in the blood and tissues toward zero This is accomplished by breathing 95 to 100 per cent oxygen Nitrogen must then go where its pressure is lowest, namely into the alveoli, from which it is exhaled Therefore, if a patient has mediastinal or subcutaneous emphysema, air in blood vessels or in the subarachnoid space or in the small intestine, the inhalation of pure oxygen will relieve the symptoms at a rate which depends on the volume of gas to be disposed of and the area of absorbing surface available The time required is not more than several hours for most of these conditions, but for distention of the small intestine twenty-four or more hours may be required Gas in the obstructed colon may require an even longer period

The *Miller-Abbott tube* is obviously a more direct method than oxygen inhalations to achieve decompression of the intestine distended by gases It cannot be used in closed loop obstruction, as in volvulus of the sigmoid Obstruction of the colon may be relieved by the tube if it can be passed through the ileocecal valve Since this takes time, the tube should not used if the degree of colonic distention is so high that the need for decompression is urgent The tube also removes fluids from the distended or obstructed gut The removal of fluids is desirable because the intra intestinal pressure is increased by the gases generated from the fermentation or putrefaction of food residues

The tube, as now used, is a double or single lumen tube weighted with a bag of mercury which greatly facilitates caudal movement of the tube If it does not pass the pylorus, it is no better than a Levin tube Frequent fluoroscopic check is essential to observe the position and progress of the tube and to assess the effectiveness of decompression Suction should be continuous to facilitate progress caudally, but *the tube must be "fed '* about 6 inches every hour to permit this The tube is withdrawn when decompression is achieved and peristalsis is resumed or the obstruction relieved otherwise Allowing

Acute Septic Parotitis

This condition is increasingly rare in modern surgical practice Oral hygiene, adequate fluid therapy and chemotherapy will pre vent or cure this infection If not, radium therapy or incision and drainage may be required

Postoperative Pulmonary Complications

A patient in bed for some time will show a depression of vital capacity and diminished respiratory reserve from the mere fact of immobilization and inactivity A further burden upon the respira tory apparatus is created by a wound which limits diaphragmatic excursion and expansion of the rib cage Incomplete inflation of the lung bases produces atelectasis and limited ability to cough and clear the tracheobronchial tree of secretions and of fluids aspirated from the nasopharynx This allows bacteria to flourish and more readily infect the lung bases, especially in elderly people The incidence of pulmonary infections after thoracotomy procedures, whether upon intrathoracic or intra abdominal viscera, is lower than after upper abdominal procedures because (1) fewer intercostal nerves are ir ritated than after conventional abdominal incisions, and (2) no direct trauma is inflicted upon muscles controlling the movement of the diaphragm and costal margins The more benign postoperative course after transverse than after vertical abdominal incisions may result from the involvement of fewer reflex arcs

The diagnosis of pulmonary sepsis is not infrequently missed or incorrectly made While roentgenography is extremely useful, it must be remembered that uncomplicated decreased expansion of the lung bases may give physical and x ray signs simulating basilar broncho pneumonia Pulmonary sepsis also may be confused with pulmonary infarction For this reason the lower extremities should always be examined in every patient with a postoperative pulmonary complica tion

The remarkable effectiveness of chemotherapy in forestalling or curing postoperative pulmonary infection has almost eliminated one of the greatest drawbacks to surgery and has widened the field of acceptable surgical risks, particularly in elderly patients It is com mon practice to administer prophylactic chemotherapy to elderly patients and to all patients with upper abdominal incisions

Thrombophlebitis and Pulmonary Embolism

This condition occurs only rarely in active healthy individuals It is frequent in people of middle or advanced age, confined to bed

Fecal Impaction

Fecal impaction is not uncommon It is seen not only in megacolon and in spastic anal disorders (fissure, ischiorectal abscess, etc) but it is especially common in debilitated patients and in those taking large amounts of syntrogel or amphogel or barium sulfate The impaction is most annoying to the alert patient It may be present unsuspected in the mentally depressed and be the cause of obstruction or diarrhea

Rectal examination will detect it readily and, if found, it is generally necessary to break the mass into fragments and sometimes to extract it manually If this produces severe pain, novocain into the anal sphincter may be used

Fever

A slight fever during the first two or three days after a major operation is to be expected because the inflammatory reaction to injury, even in the absence of infection, causes fever If the fever is high or more prolonged, infection of the wound, a hematoma, a pulmonary complication, thrombophlebitis, cystitis, etc , must be looked for to explain it The practice of giving chemotherapy without an effort to identify the cause of the fever is unwise The causative agent may not be bacterial, and if it is, correct therapy requires prompt identification

Hiccough

Persistent hiccough is usually seen in toxic conditions such as uremia, in inflammatory lesions that involve the diaphragm or phrenic nerves, such as myocardial infarction with pericarditis or basilar pneumonia but more often when blood or irritating fluids such as exudate, bile or intestinal juice are in contact with the diaphragm In many instances, especially in old people postoperatively, no explanation for the hiccough is apparent Demerol (100 mg intravenously) may relieve an obstinate case Other methods such as inhaling 5 per cent carbon dioxide in oxygen, also empirical, are of dubious value, but should be tried before resorting to opiates or more heroic measures If one phrenic nerve is crushed, relief may follow In this connection it is worth while determining whether the hiccough involves one or both leaves of the diaphragm In unilateral hiccough, paradoxical motion of the opposite costal margin may be made out by careful inspection or by fluoroscopy

A practical technic of prophylaxis for phlebitis is not available Heparin or dicumarol, given to all patients in bed before phlebitis sets in, would reduce the incidence of phlebitis, but this would involve a great burden to the hospital personnel and laboratories, as well as an unnecessary and expensive nuisance to the great majority, who are not susceptible Therefore, for the present, it is preferable to give such therapy to those who already have phlebitis or to particularly susceptible individuals, especially patients with a previous history of thrombophlebitis, patients with varicose veins, prostatitis, adults immobilized in a plaster cast for a fracture of the lower extremity, and prior to amputation for peripheral vascular disease

The presence of one or more of the following signs and symptoms indicates the existence of deep venous thrombosis (1) pain or tenderness in the calf, Achilles tendon or plantar surface of the foot, (2) swelling and hardening of the calf, (3) increased heat of the involved leg, (4) dilatation of superficial veins with or without (5) slight cyanosis, (6) slight fever and leukocytosis, (7) pain in the calf on forced dorsiflexion of the foot, with the knee straight, (8) tenderness along the superficial femoral vein (9) swelling of the thigh, indicating involvement of the iliac vein, (10) swelling of the femoral lymph nodes, (11) pulmonary embolus

A nonfatal embolus is indicated by pain in the chest, especially on inspiration, dyspnea, hemoptysis or x ray evidence of infarction The condition may be confused with acute coronary thrombosis and is distinguished from it by a more sudden onset without the typical localization of coronary pain, the presence of a higher fever and leukocytosis In embolism there is an early E K G pattern of atypical right bundle branch and a later E K G pattern of a large S_1, Q_3 and a negative T_3, indicative of acute cor pulmonale, whereas coronary occlusion with posterior wall infarction shows an early pattern of an RST rise in leads II and III and a later pattern of Q , Q_3 and negative T and T_3 (Fig 38 A, B and C) Most infarcts occur in the lower lobes, especially on the right side They vary in shape and size They produce severe tenderness on percussion of the chest over the involved area A bloody pleural tap may be obtained if fluid is present A serous pleural effusion also may be due to infarct To distinguish it from tuberculous effusion, in the absence of evidence of apical disease and of the signs of deep thrombophletitis, guinea pig inoculation may be done, but this test takes too long in the circumstances Lymphocytes due to a tuberculous process seem to be readily lysed by tuberculin This presumably is not the case in infarction The effusion due to infarct is more localized, and does not recur after aspiration, providing anticoagulant therapy has been instituted

for any reason, and occurs almost as often in medical (especially cardiac*) as in surgical patients It is a common occurrence in frac ture of the femur, after the application of plaster casts to the lower extremities for trauma, after amputation for peripheral vascu lar disease and in patients with varicose veins Death from pul monary embolism is far more common than is generally recognized

In the great majority of instances pulmonary embolism following operations does not arise from phlebitis in the veins at the site of surgical trauma, but from phletitis in the deep veins in the legs and pelvis This is also the source of most emboli in nonsurgical patients Its somewhat greater incidence in surgical patients may be due to the greater degree of immobility imposed on some surgical patients This is one of the reasons for early activation after surgery, although phlebitis may develop even in the ambulatory patient

The cause of thrombophlebitis is not known Recent work on the blood coagulation process indicates that when thromboplastin (released by trauma) reacts with prothrombin in the presence of calcium ions to form thrombin, prothrombin activators are released which autocatalyze the reaction, so that the coagulation process is rapidly speeded up If the concentration of these activators is allowed to remain high by virtue of relative stasis in the deep veins of the legs, long clots may form rapidly and break off to produce emboli

Another interesting concept, complementary to the foregoing one on the etiology of this disorder relates to the possibility of a quanti tative decline in heparin production by the mast cells † These cells are found in the connective tissue, closely apposed to the walls of capillaries, venules and arterioles Staining reactions with toluidine blue have demonstrated that these cells are the source of heparin, which, because of the intimate relation of the mast cells to the pe ripheral circulation is believed to be delivered directly into the cir culation at a point where stagnation and mechanical interference with flow is maximal The quantity of mast cells parallels the number of terminal vessels Since the number of the latter declines with age, and most strikingly in the lower extremities it is possible that the development of thrombophlebitis in the lower extremities is directly related to a partial or total loss of a continuous supply of heparin to the blood vessels in this part of the peripheral circulation

* Digitalis leaf contains a saponin which in the experimental animal exerts an *in vivo* coagulant action Saponin also inhibits dicumarol Digitoxin does not contain a saponin The high incidence of thrombophlebitis in congestive failure may in some part be due to digitalis leaf

† Jorpus J E Heparin in the Treatment of Thrombosis Oxford University Press 1946

gen, papaverine (60 mg) and atropine sulfate (1 mg) every four hours intravenously, intercostal nerve block for pain and digitalis for acute cor pulmonale or cardiac failure But *more important than any other therapeutic measure for embolism, whether mild or severe, is the immediate administration of heparin* which inhibits propagation of the clot in the pulmonary vessels as it does of a clot elsewhere Surgical attack upon the embolus is an out moded procedure because it is unnecessary and, except in the rarest instances, futile



Fig 39 Normal filling of deep system on both sides (Starr Frank and Fine J A M A *118* 1192 1942)

If the diagnosis of thrombophlebitis is doubtful, lateral and antero posterior views of the deep veins injected with diodrast via the dorsal vein of the foot may provide the evidence Venospasm or ab normal patterns in roentgenograms may give false positives

The process often exists in the total absence of all signs and symptoms and sudden death of an apparently perfectly well person from a massive embolus continues to occur all too frequently Study of such cases however, reveals that suspicious evidence of throm boembolic disease will be found more often if greater care in examin ation is taken Treatment is desirable even only on suspicion To wait for the full blown picture is to lose the opportunity of applying effec

Antibiotics do not directly influence the pulmonary reaction to in farction, but they inhibit infection which may be superimposed on an infarct The acute symptoms of infarction are treated by oxy

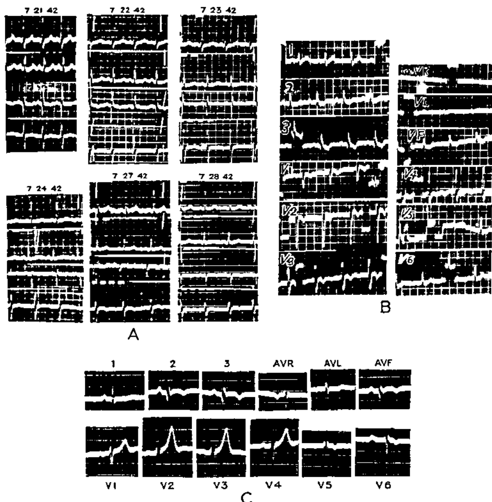


Fig 38 The electrocardiogram is often helpful in establishing a diagnosis of pul monary embolism The electrocardiograms shown in Fig 38A were obtained on six different days from a patient who had pulmonary embolism following a cholecys tectomy The characteristic features are an S wave in lead I prominent Q waves and inverted T waves in lead III and inverted T waves in the precordial lead. The rapid dis appearance of these abnormalities is characteristic of acute cor pulmonale In Fig 38B another example of acute cor pulmonale is shown this time with six unipolar precordial leads and three unipolar limb leads This should be compared with Fig 38C which dis plays the features of acute posterior myocardial infarct illustrating the similarities of the electrocardiogram in pulmonary embolism and posterior myocardial infarct The differential interpretation is made on the basis of the following features In pulmonary embolism even though a prominent Q wave is present in lead III the left leg lead has no Q or only a very small one and the T waves are inverted in the right sided precordial leads These abnormalities rapidly disappear In posterior infarct there is not only a large Q wave in lead III but significant changes are always shown in the left leg lead and a promi nent Q wave is often present in lead II as well The T waves in the right sided precordial leads are very tall If the posterior infarct extends to the lateral border of the left ven tricle Q waves and inverted T waves are found in $V_{5, 6}$ This is never found in pulmonary embolism The abnormalities in posterior infarct persist over a long period of time

In some cases of pulmonary embolism the electrocardiogram shows transient right bundle branch block

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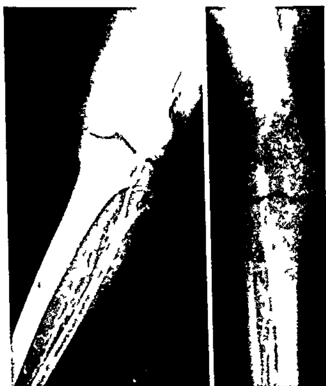


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tive prophylaxis against embolism as early as possible Even though most patients with thrombophlebitis who are not treated will escape an embolic death, many will develop late sequelae, such as swelling and ulceration Some 15 per cent will discharge emboli The first embolus may be fatal Twenty per cent of those who survive a first embolus will die of a subsequent one The older the disease, the safer from embolism the situation becomes, because of progressive conversion of clot to fixed thrombus Nevertheless, acute thrombophlebitis of the deep veins of the lower extremities is not free of the possibility of embolism at any time



Fig 40 Failure of filling of the deep veins below the popliteal is shown on the left The superficial veins are larger and more numerous on this side (Starr Frank and Fine J A M A *118* 1192 1942)

Therefore, anticoagulant therapy by heparin or dicumarol is used These drugs have disadvantages (1) Effective dicumarol dosage is difficult to predict and therefore the prothrombin time must be determined daily, (2) severe or even fatal bleeding into wounds or elsewhere may occur from either drug, (3) neither is always successful in preventing embolism especially after they have been discontinued Because of these disadvantages some prefer surgical prophylaxis of embolism

The *surgical treatment* achieves in most patients but not in all an effective prophylaxis against embolism Bilateral ligation of the

superficial femoral veins is done, since the process is or will be bilateral in more than half the patients This does not exclude an occasional embolus from the profunda femoris, but most surgeons prefer not to ligate above the profunda, i e , the common femoral vein, because there is a greater likelihood of precipitating a sudden increase in edema of the legs Ligation at either level is not satisfactory when there is edema of the thigh, or tenderness or pain in the groin, because then the process already involves the iliac veins Clots can re form and embolic discharge can still occur if a clot is found and removed from the iliac veins via an opening in the femoral vein

Postoperative edema, which is common, may be due to the fact that the phlebitis is progressing, or to a decrease in the size of the drainage bed as a result of the ligation In any case, the surgical procedure is frequently followed by an aggravation of the phlebitic process, whereas anticoagulant therapy commonly and rapidly alleviates the signs and symptoms of phlebitis and at the same time forestalls embolic discharge

Since anticoagulant therapy and femoral vein ligation, singly or in combination, sometimes fail to prevent embolism, an occasional case will require ligation of the vena cava, which can be done without danger,* providing transfusion is used when there is a resulting temporary postoperative massive effusion into the lower extremities Further embolism is effectively prevented by this procedure

Because anticogulant therapy usually cures the phlebitis and so prevents late sequelae (chronic edema, ulceration, etc), which ligation does not do, it is the method of choice when there is no danger of bleeding, such as from a fresh wound It should not be used within less than four or five days after operation, if hematoma or frank hemorrhage is to be avoided If the phlebitic process is recognized at an earlier interval or if anticoagulants are followed by embolism, ligation must be performed

Anticoagulant Therapy The pharmacology of dicumarol is not well understood Its quantitative effect on the clotting mechanism is difficult to predict in any given case The variable effects of a given dose on the prothrombin time may be due to variability in its absorption from the gastro intestinal tract or to factors in the clotting mechanism that remain obscure Dicumarol must be used with the greatest caution Its increasing popularity for the treatment of coronary heart disease as well as thrombophlebitis carries the danger that neglect to exercise the utmost circumspection in its administration will either fail to produce the desired effect or, at the other extreme, cause exsanguinating hemorrhages

* The spinal veins usually constitute an ample collateral by pass

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Therefore anticoagulant therapy by heparin or dicumarol is used These drugs have disadvantages (1) Effective dicumarol dosage is difficult to predict and therefore the prothrombin time must be determined daily, (2) severe or even fatal bleeding into wounds or elsewhere may occur from either drug (3) neither is always successful in preventing embolism especially after they have been discontinued Because of these disadvantages some prefer surgical prophylaxis of embolism

The *surgical treatment* achieves in most patients, but not in all, an effective prophylaxis against embolism Bilateral ligation of the

The use of heparin in Pitkin's medium (300 mg once every forty-eight hours) is too painful to permit its routine use There is probably more fluctuation in the blood level when given in this form than when it is administered as pure heparin, subcutaneously, every three hours in 30 mg doses This can be done by nurses An initial dose of 50 mg intravenously is followed in one hour by the same dose subcutaneously Three hours later the schedule of 30 mg every three hours is started The coagulation time will range between twenty and forty minutes

The patient should, if possible, be up and walking in his shoes, with ace or elastoplast bandages up to the knees, soon after heparin treatment is commenced Simply sitting up in a chair is not activation, it may only add stasis to immobility

If hemorrhage should occur during the use of heparin, transfuse and stop the drug Heparin is a sulfuric acid ester of a high molecular polysaccharide resembling hyaluronic acid It carries an exceptionally strong negative electric charge, which is exerted upon thrombin, prothrombin and thromboplastin Whether it does so as free heparin or as a conjugation product with a serum albumin is not established The action is a physicochemical one, and can be abolished on neutralization of its electric charge by protamine sulfate, which carries a strong positive electric charge A dose of 25 to 50 mg of pure protamine sulfate may be used clinically and will instantly inactivate all the circulating heparin

Contraindications to anticoagulant therapy are patients with a recent operation on the central nervous system, subacute bacterial endocarditis, unless arterial embolic occlusion has occurred, blood dyscrasias, threatened abortion, or pregnant women during the six weeks prior to labor Anticoagulants are to be used with caution in patients with liver disease, in renal insufficiency (defective excretion), in badly nourished or very old patients, who may be over responsive to these drugs, and in those with open or ulcerating lesions such as peptic ulcer, ulcerative colitis or open skin wounds

If the local signs and symptoms of acute thrombophlebitis of the deep veins are not relieved by anticoagulants, and if the discomfort is severe, or if fever and swelling persist, novocain block of the lumbar sympathetic trunk, repeated daily, will help to relieve the symptoms, especially if marked vasospasm is present

The extent of deep vein involvement determines the development of late complications edema, induration, varicosities, eczema, ulceration If only the veins of the calf are involved and the venous system above the popliteal remains intact, one may expect little

The following regimen may not prove to be a finally acceptable method, but, from present knowledge, will serve as a reasonably safe working technic

The dose of dicumarol is 300 mg orally on the first day (100 mg t i d), 200 mg orally on the second day (100 mg b i d), 100 mg orally on the third day (50 mg b i d) and 50 mg each day thereafter for ten to fourteen days Daily prothrombin determinations are required during dicumarol therapy, the aim being to achieve an elevation of the prothrombin time from a normal of thirteen seconds up to but not exceeding thirty seconds This average dosage of dicumarol must be adjusted in individual instances to maintain the proper prothrombin level Dicumarol acts immediately to block further prothrombin formation, but clinically effective reduction of the circulating prothrombin, i e , to below 5 per cent of normal, does not occur until during the second twenty-four hour period of its administration Since this method of giving the drug is not fully effective until some forty eight hours after beginning it, heparin, which acts at once as an antithrombin to prolong the clotting time, is also given during this period or until a proper prothrombin time is obtained The first prothrombin determination must be made not less than three hours after the last dose of heparin, in order to avoid the effect of heparin itself on the prothrombin time The action of dicumarol is unpredictable Hemorrhage has occurred after discontinuing it Aspirin, caffeine and aminophyllin should not be administered during dicumarol therapy, since they interfere with its action If hemorrhage occurs during or after its administration, vitamin K in large amounts (30 to 60 mg menadione bisulfate or, better, vitamin K_1 oxide intravenously) and whole blood or lyophilized plasma transfusions are useful antidotes

Heparin is preferred to dicumarol because it is safer While it is rapidly excreted and does not demand special laboratory control if given in proper amounts, it is desirable once a day to check the clotting time which should range between twenty and forty minutes Heparin may be given intravenously according to the following dose schedule, although caronamide (see p 47) may be used to decrease the frequency and amount of each dose

First three days	
8 00 A M	125 mg
12 00 NOON	100 mg
4 00 P M	100 mg
8 00 P M	150 mg
Fourth to sixth or seventh day	
8 00 A M 4 P M and 10 P M	100 mg

therapy, mandelic acid, acidification of the urine and restricted fluids may prove more effective

Oliguria or Anuria

Dehydration and *traumatic shock* are causes of oliguria, which, if properly treated, will be followed by prompt restoration of a normal volume output *Incompatible blood transfusion*, which produces a chill, fever, pain in the flanks, vomiting and oliguria ("smoky urine") or anuria is a grave complication that is often fatal Rapid alkalinization is required to minimize the deposition of hemoglobin casts in the urine Occasional spontaneous recovery occurs, with spontaneous diuresis appearing usually about the eleventh or twelfth day after onset of the disorder Do not force fluids in such patients Limit the intake to 1000 cc plus the volume of urinary output in order to avoid pulmonary edema Renal decapsulation, repeated high spinal anesthesia or recent methods of artificial dialysis of the blood stream may be tried (See chapter on Renal Disorders)

Sulfonamides may cause oliguria or anuria The oliguria is said to result from mechanical block by crystals and to be preventable by adequate alkalinization of the urine It is probable, however, that a toxic tubular nephritis is a more likely cause than crystalluria, even when the latter is actually present Fractional doses of two or three sulfonamides, totaling the normal dose of any single sulfonamide, are said to be less likely to result in a renal injury, because of the increased solubility of each when combined with a solution of other similar compounds

Bilateral ureteral ligation as a cause of anuria should be suspected after vaginal hysterectomy or other pelvic surgery

In any case of anuria or oliguria not due to mechanical block, the induction of diuresis should be attempted by intravenous therapy if the patient cannot take or retain swallowed fluids If there is dehydration, use dextrose in saline solution If there is shock, give blood or plasma If there is edema, restrict the intake to not over a liter daily and omit sodium chloride If there is pulmonary edema, give no fluids except intravenous concentrated glucose (See chapters on Fluid and Electrolyte Balance and on Renal Disorders)

NEUROLOGIC COMPLICATIONS

Cerebral thrombosis, embolism or hemorrhage produces disturbance in consciousness, delirium or restlessness Hemiparesis, hemiplegia, stiff neck and bloody spinal fluid are the common signs of

trouble If the veins of the femoral system are occluded, there may be complications so distressing as to produce chronic disability The therapeutic responsibilities, therefore, embrace more than the immediate threat of embolism

UROLOGIC COMPLICATIONS

Urinary Retention

(See discussion of Bladder Care, p 465 and chapter on Urologic Disorders)

If an organic nerve disorder is the cause of retention, automatic bladder function may be established or constant urethral or suprapubic drainage instituted and combined with tidal irrigation, using the "M" solution of Suby and Albright, containing citric acid, magnesium oxide and sodium carbonate, to prevent calculus formation in the bladder or incrustations in the irrigating system

Other causes of retention, such as bladder calculus, contractures of the urethra stricture of the vesical neck, prostatism or prostatic hypertrophy may appear postoperatively for the first time and require the service of a urologist

Postoperative Cystitis

Postoperative cystitis, resulting from local or distant sources of infection, is treated by a large fluid intake, local heat (heating pad, vaginal or rectal irrigations or sitz baths), alkalinization of the urine (sodium bicarbonate 2 gm , q 4 h) and chemotherapy (1 gm , q i d , of sulfamethazine or sulfadiazine or 1/4 gm , q i d , of streptomycin, or penicillin, depending on the sensitivity of the offending organism) Penicillin or sulfamethazine is used for coccal organisms, streptomycin or sulfamethazine for gram negative organisms *B proteus* and *B pyocyaneus* are most likely to yield to streptomycin, but sulfamethazine should be used first If penicillin or streptomycin is used first and is not effective, sulfamethazine may succeed Aureomycin, 80 mg t i d , intramuscularly, promises to excel all other antibiotics now in use for cystitis

If in addition to cystitis there is a residual which is not treated adequately ascending infection (acute pyelonephritis) is very likely *E coli* is the commonest offender If study reveals no complicating pathologic condition the treatment is similar, i e , ample fluid intake (4000 cc or more daily) heat to the renal area alkali therapy and chemotherapy as described

The urine should be sterile in most cases within forty eight hours, but chemotherapy is continued for about a week If the infection persists and becomes chronic and does not yield to the foregoing chemo

therapy, mandelic acid, acidification of the urine and restricted fluids may prove more effective

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NEUROLOGIC COMPLICATIONS

Cerebral thrombosis, embolism or hemorrhage produces disturb ance in consciousness, delirium or restlessness Hemiparesis, hemi plegia stiff neck and bloody spinal fluid are the common signs of

these complications Toxic myelopathy due to spinal anesthesia usually becomes manifest within twenty four hours following operation If this occurs, bedsores and bladder infections are serious developments that should be prevented if possible

General care of the paralyzed patient Patients who have developed hemiplegia with spasticity require early massage and passive movements to minimize rigidity and prevent ankylosis Splints or other types of mechanotherapy may be needed to prevent deformities Muscle training exercises may be of value in some cases Educational therapy is of help in some types of aphasia

Peripheral nerve palsies may follow improper positioning during operation Thus the brachial plexus may be overstretched by hyperabduction of the arm on the board used for transfusions or axillary surgery, or by the steep Trendelenburg position, in which the body may be virtually suspended upside down by the wrist bracelets, or by allowing the shoulder brace to press on the soft supraclavicular structures A flexed elbow permits pressure by the edge of the operating table to damage the ulnar nerve In the lithotomy position, the stirrup may compress the saphenous nerve, or the support upon which the back of knee rests may press upon the common peroneal nerve and cause foot drop The loss of muscle tone under anesthesia, and the inability during the unconscious state to resist what cannot be tolerated in normal circumstances, makes due care in handling the unconscious patient a compelling necessity Most of these injuries clear up in a few days or weeks, but some persist indefinitely The damage, once done, can only be treated by physiotherapy and other orthopedic measures

CHAPTER 50

OXYGEN THERAPY

Oxygen is used for relief of anoxia, in resuscitation, for the removal of gas trapped within the body (intestinal obstruction, following air encephalogram) and for the dispersal of a therapeutic agent, as an aerosol fog

Oxygen may be used in the following conditions

A Decreased total effective pulmonary alveolar area, as in
  1 Pulmonary edema—due to congestive heart failure or infection or overhydration
  2 Pulmonary consolidation—due to pneumonia, atelectasis or infarction
  3 Circulatory changes in the lungs—embolism

B Chemically defective oxygen transport system, as in
  1 Acidosis—due to uremia or diabetes mellitus
  2 Severe anemia—resulting from blood loss, blood dyscrasias
  3 Abnormal forms of hemoglobin—caused by carboxy-, sulfa , or methemoglobinemia

C Mechanically defective oxygen transport system, as in
  1 Respiratory paralysis, due
    a to disorders of the central nervous system
      (1) bulbar poliomyelitis, multiple sclerosis, etc.
      (2) electric shock
      (3) head injuries
      (4) intracranial vascular accidents
      (5) intracranial neoplasm
      (6) poisonings, as by carbon monoxide, barbiturates, anesthesia
    b to disorders of the peripheral nervous or muscular system myasthenia gravis, curare poisoning
  2 Obstructive lesions of the larynx, trachea, bronchi—due to
    a mechanical block, as by tumors or foreign bodies
    b physiopathologic, as in asthma

c inflammatory, resulting from exposure to industrial irritants such as chlorine, ammonia and sulfur dioxide or severe tracheobronchitis or bronchitis

D Oxygen may be used in conditions other than anoxia

1 Intestinal distention
2 Air encephalography
3 Mediastinal emphysema
4 Aerosol inhalations
5 Air embolism

DISCUSSION

The conditions in group A all reduce the total effective alveolar area It is in this group that oxygen therapy is most effective

In group B, where anoxia is due primarily to a chemical defect resulting in altered carrying capacity of the blood for oxygen and carbon dioxide, oxygen therapy may be expected to be less effective for the relief of anoxia Other more physiologic methods must be attempted in order to influence the disorder in a more fundamental manner, such as transfusion or restoration of a normal acid base balance However, inhalation of high partial pressures of oxygen can be useful, e g , in the presence of carboxyhemoglobinemia high oxygen concentrations will shift the equilibrium toward the reformation of normal oxyhemoglobin, with increased rate of release of carbon monoxide

In traumatic shock, anoxia is the result of inadequate blood flow rather than defective oxygenation of blood as it passes through the lungs, so that oxygen inhalation may be expected to be of little or no value

Group C lists the mechanical causes of anoxia Group C 1 includes a variety of causes for respiratory paralysis This group of patients requires that air shall move in and out of the lungs in the normal minute volume of the resting patient Various resuscitative measures have been described for this purpose Oxygen may be used for this group of patients in two ways (1) The best method is to utilize the kinetic energy stored in the oxygen tank as the source of power for inflating the lungs periodically to a predetermined pressure (15 cm of water) with release of the pressure during expiration, so that the lungs empty by means of the elastic recoil of the pulmonary parenchyma, and of the chest wall itself Such an apparatus is available (2) The suck and blow type of resuscitator ordinarily used is not satisfactory because the negative pressure phase does not increase

tidal exchange and probably creates or increases congestion of the lungs

Group C 2 patients are anoxic because of narrowing of the passage ways conducting oxygen to the alveoli There are two ways to attack this problem (1) Give the patient oxygen in concentrations greater than that found in normal air, in the hope that the increased partial pressure of the oxygen will make up for the decrease in tidal volume, or (2) decrease the viscosity of the respiratory gas This may be done by giving a mixture of helium and oxygen, containing about 20 per cent oxygen The viscosity of this mixture is sufficiently lower than that of air or pure oxygen so that the patient can increase his tidal volume to a tolerable level

Group D lists nonanoxic indications for oxygen therapy Nitrogen constitutes the largest fraction of trapped gases in the intestine as well as elsewhere When pure oxygen is breathed, the partial pressure of nitrogen in the inhaled gas is zero The pressure of nitrogen in the blood and tissues, which is high, then rapidly falls toward zero Therefore, it diffuses out with increasing rapidity (See section on Gaseous Distention of Intestine, p 478)

The kinetic energy of compressed oxygen is used as the means for dispersing solutions of therapeutic agents into a fine aerosol spray An example of this is penicillin aerosol, used in the treatment of bronchiectasis

METHODS OF ADMINISTRATION

The several methods for getting oxygen from a cylinder, in which it is compressed to 2200 pounds per square inch to the patient's respiratory tract in such form as to be physiologically and mechanically acceptable, all include a reducing valve that controls the rate of flow of oxygen at close to atmospheric pressure The several types of equipment that may be used are tabulated below

A Continuous flow via

1 Nasal catheter in the nasopharynx When obstruction is lower down, the catheter may be introduced through a laryngoscope into the trachea as far down as the carina

2 Mask

a Celluloid mask

b BLB mask, with rebreathing bag

c Other masks

3 Tent

Tents are available varying from a simple hood over the patient's head to elaborate devices that include much of the

c inflammatory, resulting from exposure to industrial irritants such as chlorine, ammonia and sulfur dioxide or severe tracheobronchitis or bronchitis

D Oxygen may be used in conditions other than anoxia

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2 Air encephalography
3 Mediastinal emphysema
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5 Air embolism

DISCUSSION

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Close this valve when oxygen is not in use The tank will empty in a day or two if only the valve of the reducing regulator is shut off

Never apply a wrench to the oxygen cylinder valve It is not necessary and will destroy the valve seat If the valve cannot be closed easily by hand, it is defective and should be returned for repair

Oxygen Regulators

1 Connect to the cylinder by tightening the joining bolt by hand Then, keeping it tight with the left hand, turn the entire regulator a few degrees in a clockwise direction to seat the juncture firmly Usually a wrench is not needed to make the connection gas proof If a wrench is used, use it gently

2 Handle the valve controlling flow on the regulator gently It is easily damaged

3 Connections between oxygen regulator and mask should be made only with rubber tubing that is at least as large in inside diameter as the diameter of the delivery orifice of the regulator The use of constricting glass connectors between lengths of rubber tubing must be strictly avoided, for they markedly obstruct the flow of oxygen through the system

4 Masks A mask is only as good as its fit If a mask fits poorly, it will function inefficiently

Safeguards

1 An oxygen cylinder falling over onto its side can inflict serious injury

2 The neck of an oxygen cylinder can, in certain circumstances, actually be knocked off This converts the cylinder into a rocketing shell of great destructive power, sufficient to drive it right through the wall of a building *Do not let cylinders topple over* Guard against this type of accident

3 Oxygen cylinders in the vicinity of a fire should be removed to a place of safety just as certainly as explosives should be so moved

4 Fire—cigarettes, matches, electric cautery—is strictly forbidden in areas where oxygen gas is in use

5 Never apply oil to any equipment being used for the control of oxygen A drop of oil in a regulator may convert it and the cylinder to which it may be connected, into a powerful incendiary mechanism

Note Because of these and other considerations, the installation of a central depot from which oxygen is piped to the bedside is becoming increasingly popular

bed as well as the patient, and are provided with circulating blowers for passing the contained gas over ice, thereby controlling temperature and humidity to a certain extent

B Intermittent flow

There are three forms of this method

1 Supply on demand by the patient This type of equipment uses a well fitting mask As the patient inhales, a valve is actuated which supplies him with exactly the amount of oxygen that is required with each breath This method is the only one that provides the patient with oxygen undiluted with air

2 Intermittent positive pressure breathing This method provides the patient with pure oxygen at increased pressure (12 cm of water) during inhalation only There is some evidence to show that this may be of value particularly in the treatment of pulmonary edema associated with heart failure Its value for infant resuscitation is not yet demonstrated

3 Continuous positive pressure breathing This method provides the patient with increased positive pressure during both inhalation and exhalation Its value is not proven and has certain disadvantages

CHOICE OF APPARATUS

Selection of apparatus may be made primarily by deciding how much oxygen the patient actually needs The proper amount of oxygen is determined just as the proper amount of any other medicament is determined—by the amount that is required to produce the desired effect For the relief of mild cyanosis, any of the continuous flow types of equipment will serve well enough When the respiratory efficiency of the patient is more seriously impaired and a higher concentration of oxygen is desirable, a demand method should be used

CARE AND HANDLING OF APPARATUS

Oxygen cylinders contain 220 cubic feet of oxygen compressed to 2200 pounds per square inch and they are provided with an efficient needle valve for controlling the escape of oxygen An adequate flow is provided by one half to three fourths of a turn of the handle of the needle valve counterclockwise More turning is unnecessary

rarely occur In less favorable circumstances, palliation may be secured by combining both methods

Although attempts to treat disseminated cancer by chemical means are not new, research in this direction has been given an im petus by the notable successes with the antibiotics A semi empirical approach is today considered to be legitimate research A cancer cure has not been provided by any of the agents so far investigated, but palliation of certain malignancies has been achieved

Nitrogen mustard (methyl bis chloroethyl amine) has been found to be of greatest benefit in Hodgkin's disease This drug pro duces improvement in the leukocyte count and anemia, diminution in the size of tumors, gain in weight and strength in some patients sufficient to enable a return to work The effects simulate x ray therapy, but may be observed in patients that are already radio resistant In lymphosarcoma, lymphatic and myelogenous leukemia the beneficial results obtained are not superior to what can be pro vided by x ray therapy

Urethane (ethyl carbamate) has been found of value in acute and chronic myeloid leukemia, and of less benefit in lymphatic leukemia The effect on the leukocyte count and anemia, the reduction in size of the spleen and the clinical improvement are similar to that produced by x rays Benefit has also been observed in radio resistant cases As is the case for the mustards, permanent benefit has not been observed, nor has life expectancy been prolonged

Trifolic acid and its antagonist, *aminoptyrin,* have produced partial destruction of certain tumors in children Aminoptyrin has produced some beneficial effects in acute leukemia in children

Estrogens and *androgens* produce partial regression of some breast carcinomas Stilbestrol works best in the aged and testosterone is used in patients in the menstruating age Disappearance of pul monary metastases and calcification of bone metastases with relief of pain has been observed in isolated instances Stilbestrol, and especially orchiectomy, have a striking palliative effect on prostatic carcinoma Blood acid phosphatase diminishes, metastases regress and bone pain is relieved from months to years These agents have not produced any benefit in other types of tumors

Radioactive Iodine

Although the administration of radioactive iodine is not strictly chemotherapy, it may be mentioned here as a useful palliative agent in some 15 per cent of tumors of thyroid origin The selection of patients suitable for this therapy is made by determining the ability

CHAPTER 51

SPECIAL AND SPECIFIC MEDICATION

The complete official name of each drug should be used in writing orders Proprietary names of preparations should be avoided when ever possible, since equally effective and often identical official drugs are generally available at much less cost For example, adrenalin is a trade name for epinephrine and when ordered as adrenalin it is much more expensive

The metric system should be used exclusively Common equivalents are listed below

METRIC	APPROXIMATE APOTHECARY EQUIVALENTS (GRAINS)
1 0 gm	15
0 6 gm	10
0 5 gm	7 1/2
0 3 gm	5
0 2 gm	3
0 1 gm	1 1/2
60 0 mg	1
30 0 mg	1/2
20 0 mg	1/3
15 0 mg	1/4
10 0 mg	1/6
8 0 mg	1/8
0 6 mg	1/100
0 4 mg	1/150
0 3 mg	1/200

CHEMOTHERAPY OF MALIGNANT DISEASE

Until recent years methods of treating cancer have been limited to either surgery or radiation or both Surgical cures can be expected only when tumors are sufficiently localized and accessible to enable complete extirpation Cures by radiation can be expected only when tumors are sufficiently radiosensitive and are located in accessible areas to provide selectively a concentration of radiation high enough for destruction of every tumor cell These favorable circumstances

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of the tumor to concentrate tracer doses In most cases of "functioning" thyroid tumors, the selective uptake of radioactive iodine is very limited For this reason large doses of I^{131} (half life eight days), up to 200 millicuries, are usually required The results are dependent on the avidity for iodine of the particular tumor and its metastases Attempts to increase the avidity for iodine by thyrotropic hormone or by thyroidectomy in patients with metastases are in progress

Radioactive Phosphorus

Radioactive phosphorus provides the same palliative effect as x ray therapy in chronic myelogenous leukemia It may be of value in chronic lymphatic leukemia It is less consistent in its effect on Hodgkin's disease and lymphosarcoma It is of no value in acute leukemia Although the results in polycythemia vera are good, there are other equally effective and safer methods of treating this disease Because P^{3} has a long half life (fourteen days) and because the response to it varies markedly from patient to patient, the regulation of dose is difficult

Tolerance of Tumors to Cancericidal Agents

Human tumors have demonstrated the ability to develop a tolerance to every agent so far studied Even tumors that seem to yield quickly to radiation therapy and to hormones eventually escape from such control and establish complete autonomy Until an agent is provided which will destroy every malignant cell within a reasonable time, it may be expected that the development of tolerance to the cancericidal agent will ensue, with at best a palliative result

Drugs Used in Care of Surgical Patients

(See tables on pages 505 to 514)

SPECIAL AND COMMON DRUGS OF VALUE IN THE CARE OF SURGICAL PATIENTS

TABLE 1

Central Nervous System Stimulants

These drugs are used to stimulate the central nervous system The intensity of action on cortical subcortical and medullary centers varies with each drug and with different drugs They are of value in central nervous system depression due to various causes including drug intoxication and acute circulatory collapse

DRUG	ROUTE OF ADMINISTRATION	FORM AVAILABLE	DOSE	REMARKS AND INDICATIONS
Nikethamide N N R (one trade name Coramine)	S C	Ampule 1 5 cc (25% solution)	1 5 cc	No direct cardiac action
Metrazol N N R (once known as Cardiazole)	S C I M I V	Ampule 1 to 3 cc (10% solution)	1 to 3 cc	No direct cardiac action
Caffeine Sodium Benzoate U S P	I M I V	Ampule 2 cc (25% solution)	0 5 gm	Some direct myocardial stimulation Intravenously for lumbar puncture headache
Amphetamine Sulfate N N R (Benzedrine)	Oral S C	Tablets 5 and 10 mg Ampules 10 mg	5 to 10 mg oral or s c	
Ephedrine Sulfate U S P	Oral S C	Capsule 50 mg Ampule 10 mg	50 mg oral 10 mg s c	
Picrotoxin (U S P)	I V	Ampule 10 mg	10 mg single dose	Chiefly used for barbiturate intoxication in 1 1000 solution
Sodium Succinate	I V	30% solution	5 cc initially then 1 cc per second	Given for barbiturate poisoning in increasing amounts as needed to restore function

TABLE 2

DRUGS FOR THE TREATMENT OF PAIN

For pains which are not very severe try
(1) Acetylsalicylic acid (aspirin) 0 3 to 1 0 gm every 2 to 3 hours
(2) Acetylsalicylic acid compound (acetylsalicylic acid acetophenetidin caffeine) 0 5 to 1 0 gm every 2 to 3 hours

For more severe pain the following narcotics are available (see p 459–464)

DRUGS	NATURAL OR SYNTHETIC	ROUTE OF ADMINISTRATION	DOSE	REMARKS
Codeine Sulfate U S P	Natural	Oral S C	16 to 60 mg	Often given together with acetylsalicylic acid compound useful for dry cough
Meperidine Hydrochloride, N N R (Demerol)	Synthetic	Oral S C	50 to 100 mg	Analgesic potency between codeine and morphine Some antispasmodic action on smooth mu cle
Morphine Sulfate or Hydrochloride U S P	Natural	Oral S C (I V)	8 to 30 mg	Occasionally the i v route is useful for quick relief of extremely severe pain
Dilaudid N N R	Synthetic	Oral S C	2 to 4 mg	To avoid side effects of morphine (nausea vomiting)
Pantopon	Mixture of opium alkaloids in natural proportions	Oral S C	20 mg	About 50% morphine To avoid morphine side effects
Metapon Hydrochloride N N R	Synthetic	Oral	3 to 15 mg	Available for the treatment of incurable malignancy

Note Do not use opiates in myxedema Use sparingly and cautiously in emphysema or wherever anoxia is due to respiratory inefficiency Use cautiously in liver disease

All the narcotics may be habit forming and their use is *regulated by* Federal *(Harrison* Narcotic *Act) and State regulations*

The responsibilities of the physician under the Harrison Narcotic Act are outlined by W C Woodward in J A M A *96* 1771 1931

TABLE 3

SEDATIVES AND HYPNOTICS

DRUG	ROUTE	FORM AVAILABLE	DOSE	REMARKS
Bromide Sodium or Potassium U S P	Oral	Tablets	Sedation 1 gm 3 or 4 i d use more for hypnosis	
Triple Bromide (tablet of three bromides) contains 0 3 gm each of ammonium potassium and sodium bromide				
Chloral Hydrate, U S P	Oral Rectal	Solution (mask taste) 4 cc to 0 3 gm	Hypnosis with 0 5 to 1 0 gm	May be given rectally dissolved in oil
Paraldehyde U S P	Oral Rectal I M I V	Liquid—poorly soluble in water	3 to 15 cc. 10 to 20 cc 5 to 10 cc 2 to 5 cc	One of the least toxic hypnotics—excellent for older individuals Difficult to disguise taste

Barbiturates may be selected on basis of duration of action

DRUG	ROUTE	FORM AVAILABLE	DOSE	REMARKS
Phenobarbital (Luminal) U S P	Oral Sodium salt—s c	Tablets powder for solution	0 1 to 0 2 gm for hypnosis	Long acting Sedation with 15 to 30 mg t.i d.
Pentobarbital Sodium (Nembutal) U S P	Oral	Capsules	0 1 to 0 2 gm for hypnosis	Moderate duration
Evipal N N R	Oral	Tablets	0 25 to 0 4 gm for hypnosis	Short acting Sodium salt used i v as general anesthetic Do not use in severe liver disease Have oxygen available
Seconal Sodium N N R	Oral	Capsules	0 1 to 0 2 gm for hypnosis	Short acting

Note Soluble barbiturates 0 3 to 0 5 gm intravenously are useful for treatment of procaine reactions

TABLE 4

MISCELLANEOUS DRUGS ACTING ON THE CARDIOVASCULAR SYSTEM

DRUG	INDICATION	ROUTE OF ADMINISTRATION	FORM AVAILABLE	DOSE	REMARKS
Digitalis U S P	Congestive heart failure and certain cases of paroxysmal tachycardia	Oral (See note)	Tablet 0 1 gm Ampules	Size of individual dose and frequency of administration to be decided in each case	
Quinidine U S P	Paroxysmal tachycardia	Oral I M	Tablet 0 2 gm Solution 0 15 gm /cc	Size of individual dose and frequency of administration to be decided in each case	
Nitroglycerin U S P	Angina pectoris	Sublingual	Tablet 0 12 0 3 0 6 mg	One tablet and repeat as needed	Unpleasant side effects—headache flushing—may be minimized by using smallest dose
Theobromine Sodium Acetate U S P	Angina pectoris congestive failure (as a diuretic)	Oral	Tablet 0 5 gm enteric coated	0 5 gm four times a day	
Mercurial Xanthine compounds (Mercuzanthin Mercuhydrin)	As diuretics	I M I V	Ampule 2 cc	1 to 2 cc repeated as needed	Preparations are available for oral use

Note Purified digitalis glucosides are available for parenteral use e g digifolin Pure digitalis glucosides are available for oral administration and for parenteral use in urgent cases e g digitoxin lanatoside C

DRUGS USEFUL FOR GASTRO INTESTINAL SYMPTOMS

TABLE 5

CATHARTICS AND LAXATIVES (all used orally)

DRUG	FORM AVAILABLE	DOSE	TIME OF ACTION	REMARKS
Irritant cathartics act by irritation of intestine				
Cascara Sagrada U S P	Tablet Fluid extract Elixir	0 3 gm 2 to 4 cc 4 to 8 cc	8 hours	
Castor Oil U S P	Liquid Emulsion	15 to 30 cc 30 to 45 cc	2 to 6 hours	
Saline cathartics retain water which stimulates intestinal activity				
Magnesium Sulfate U S P (Epsom Salt)	Salt	15 gm	1 to 3 hours	
Milk of Magnesia (aqueous suspension 8% Magnesium Hydroxide)	Liquid	15 cc	1 to 3 hours	
Sodium Phosphate U S P	Salt	4 to 8 gm	1 to 3 hours	Effervescent sodium phosphate contains tartaric acid and sodium bicarbonate
Liquid Petrolatum U S P	Liquid	15 to 45 cc	12 hours	
Phenolphthalein U S P	Tablets	0 1 to 0 2 gm	4 to 8 hours	Compound phenophthalein pills— Alophen

Various combinations may be used e g liquid petrolatum and milk of magnesia or cascara

TABLE 6

DRUGS USEFUL IN TREATING GASTRO INTESTINAL SYMPTOMS

DRUG	ROUTE OF ADMINISTRATION	FORM AVAILABLE	DOSE	REMARKS
		Antispasmodics		
Atropine Sulfate U S P	Oral S C	Tablet	0 4 to 0 8 mg every 3 to 4 hrs	Give enough to get effect or until blurred vision and dry mouth occur
Tincture of belladonna U S P	Oral	0 2 mg atropine in 0 6 cc of vehicle	10 to 15 drops 3 or 4 i d	
Homatropine Methyl Bromide (Novatrine) Syntropan N N R Trasentin N N R				These are *synthetic* antispasmodics that probably are of no greater value than atropine
		For Treatment of Diarrhea		
Bismuth Subcarbonate U S P	Oral	Powder	2 5 gm repeat in 2 to 3 hrs	The subcarbonate is preferable to the subnitrate which may cause methemoglobinemia
Kaolin (anhydrous aluminum silicate) N F	Oral	Colloidal suspension	50 to 100 gm repeat q 3 h	
Paregoric (camphorated tincture of opium) U S P	Oral	0 04% morphine (4 cc contains 1 6 mg morphine)	4 cc repeat q 3 h p r n	
Tincture of Deodorized *Opium* U S P	Oral	1% morphine (1 cc contains 10 mg morphine)	0 3 to 2 cc repeat in 3 to 4 hrs p r n	Quick acting Preferable for severe or persistent cases

TABLE 7

DRUGS USED IN THE TREATMENT OF ASTHMA AND OTHER ALLERGIC CONDITIONS

DRUG	ROUTE OF ADMINIS TRATION	FORM AVAILABLE	DOSE	REMARKS
Epinephrine Hydrochloride (adrenalin) Solution U S P	S C	1 1000 (1 cc to 1 mg)	Up to 0 5 cc repeat p r n	Used i v diluted with saline 5 cc in 1500 cc saline given slowly
Epinephrine in oil (peanut or sesame oil) N N R	I M	1 500 (1 cc to 2 mg)	1 cc repeat in 6 to 8 hours	
Ephedrine Sulfate U S P	Oral	Capsules	24 mg q 3 to 4 h	Popularly combined with pheno-barbital and theophylline
Propadrine Hydrochloride N N R	Oral	Capsules	24 mg q 2 to 4 h	May cause less central nervous system stimulation than ephedrine
Atropine Sulfate U S P	Oral S C	Tablets	0 5 mg q 2 to 4 h p r n	Not nearly as reliable as epinephrine
Aminophylline U S P	I M or I V Oral	10% solution Tablets	0 25 gm 0 1 to 2 mg q 3 to 4 h	For acute attack of bronchial asthma. Pulmonary edema May be toxic.
Diphenhydramine Hydrochloride (Benadryl) N N R	Oral I V	Capsules	50 to 300 mg repeated p r n	May be given i v Useful in hives or hay fever Drowsiness is a common side effect
Tripelenamine Hydrochloride (Pyribenzamine) N N R	Oral	Tablets	50 to 300 mg repeated p r n	Useful in hives and hay fever Drowsiness is a common side effect

For the acute attack of asthma the best drugs are epinephrine 1 1000 aminophylline (i v) for prophylaxis ephedrine aminophylline (oral)

TABLE 8

Sympathomimetic Drugs for Various Purposes

GENERAL ACTION	DRUGS OF CHOICE	DOSE	REMARKS
Circulatory collapse	Epinephrine	Up to 1 cc s c 1 1000 solution	Causes tachycardia and increased cardiac work Contraindicated in coronary heart disease
	Paredrine	10 to 20 mg s c	No direct cardiac action } This is important where cardiac disease is present
	Neosynephrine	5 mg s c	No direct cardiac action }
Anti allergic (see Table 7)	Epinephrine	Up to 1 0 cc 1 1000 solution	For the acute attack
	Ephedrine	24 mg orally t i d	For prophylactic action May cause C N S stimulation
Central nervous system stimulation	Amphetamine	10 mg i v 5 to 10 mg orally	May cause headache
Nasal vasoconstriction	Neosynephrine	0 25% solution	2 to 3 drops every 2 to 3 hours Most of these drugs produce some degree of after congestion due to vasodilatation Two per cent cocaine solution may be added for better effect

TABLE 9

MISCELLANEOUS DRUGS FOR SPECIFIC PURPOSES

DRUG	DOSE	INDICATION	REMARKS
Adrenal Cortical Extract	Variable requirements	Adrenal insufficiency	Slow intravenous *drip of a 1 10 000 solution*
Caffeine Sodium Benzoate	0 5 gm i v	Lumbar puncture headache	Repeat q 3 to 4 h if needed
Calcium Gluconate 10% Solution U S P	5 to 10 cc i v	Ureteral colic Tetany due to low calcium	
Carbaminoylcholine (Doryl)	0 25 mg s c	Postoperative urinary retention	Side effects are those of parasympathetic stimulation May need large doses of atropine to counteract side effects.
β Meythl Choline (Urecholine)	5 0 mg t i d oral	Gastric retention	
Demerol N N R	100 mg i v	Intractable hiccough	Use cautiously—occasionally effective
Diethylstilbestrol	0 5 to 1 0 mg daily orally	Menopausal syndrome	Side reactions may indicate trial *of a natural estrogen*
	15 mg orally	Prostatic carcinoma and metastases	
Dihydrotachysterol (A T 10) 5 mg per cc in oil	3 cc daily For maintenance 0 3 to 1 cc daily	Hypoparathyroidism postoperative or idiopathic	Overdose may cause hypercalcemia
Ergotamine Tartrate N N R (Gynergen)	0 25 mg i m and repeat 2 to 3 hours p r n Orally 2 to 3 mg or 1 mg hourly for 4 or 5 doses	Migraine	Acts by vasoconstriction. May interfere rarely with peripheral blood flow and cause gangrene
Ethinyl Estradiol	0 05 mg 1 to 3 daily orally	Menopausal syndrome	To be tried after diethylstilbestrol
Fluorescein N N R (solution of sodium fluorescein 2%)	Few drops on cornea	For outlining foreign bodies and ulcerated areas	Ulcer shows as a green area
Furfuryl trimethyl Ammonium Iodide (Furmethide ')	3 mg s c 10 mg orally	Urinary retention due to bladder atony	Parasympathomimetic side reactions (intestinal colic sweating) may occur and may be severe This effect disappears after a few doses

TABLE 9 (*Continued*)

MISCELLANEOUS DRUGS FOR SPECIFIC PURPOSES

DRUG	DOSE	INDICATION	REMARKS
Multivitamin Preparation	1 or more per day	Supplement to diet	Contents of one capsule approximate N R C maintenance requirements per day
Neostigmine Methyl Sulfate U S P (Prostigmine)	5% solution	To produce miosis in glaucoma	
	1 0 mg s c	Pregnancy	Bleeding will follow in 24 hours if not pregnant.
	0 5 to 1 0 mg s c or 0 25 mg q 1 h for 6 doses	Intestinal distention	Side effects prevented by atropine sulfate 1 to 2 mg s c
	0 5 mg s c	Myasthenia gravis	If the bromide salt by mouth is preferred give 15 to 30 mg t i d or oftener
Parathyroid Hormone N N R 100 units per cc	1 to 3 cc	Parathyroid tetany	Raises serum calcium Overdoses may produce hypercalcemia
Potassium Iodide U S P	Saturated solution 0 3 cc t i d	Thyrotoxicosis	1 cc contains 1 gm potassium iodide
Quinine U S P	0 3 to 0 6 gm t i d	Myotonia congenita	Relieves muscular cramps in this disease and will help night cramps in legs
Therapeutic Vitamin Preparation	1 or more daily	Therapy of vitamin deficiencies	Contains 5 to 10 times the maintenance requirements
Vitamin D U S P	25 000 to 50 000 units daily	Used with calcium salts in maintenance treatment of hypoparathyroidism	
Vitamin K_1 oxide	Given intravenously in saline	Hemorrhagic tendency due to deficient prothrombin formation	Used in hypoprothrombinemia from obstructive jaundice or from drug e g dicumarol Action of K_1 oxide more rapid than K
Vitamin K, U S P (Menadione)	1 to 2 mg daily orally or i m		

CHAPTER 52

TREATMENT OF COMMON ACUTE POISONING

Therapy of acute poisoning includes (1) removal of the intoxicating agent, (2) administration of antidotes, (3) supportive therapy Often the patient is seen too late to permit removal and specific antidotes are uncommon For the most part, therapy depends on intelligently directed supportive measures

1 Central Nervous System Depressants—barbiturates, morphine, ethyl alcohol etc

a The stomach is lavaged thoroughly with warm water Potassium permanganate 1 5000 is useful, but if it is not readily available, do not delay lavage Magnesium sulfate, 30 grams, may be left in the stomach to induce catharsis During lavage the patient's head should be low and turned to one side Care should be taken that the patient does not inhale aspirated fluid and that an airway is maintained

b Treatment of respiratory and vascular depression

(1) Artificial respiration, resuscitator or Drinker respirator, if respiration has virtually ceased

(2) Oxygen therapy if anoxia is severe Intermittent inhalation of 5 per cent carbon dioxide and 95 per cent oxygen may be used, if indicated, to increase the excretion of volatile poisons, such as ether

(3) Respiratory stimulants These are used in relatively large dosage in proportion to the depth of narcosis

Caffeine sodium benzoate—1 0 gram intramuscularly or intravenously every one to two hours

Nikethamide—2 to 3 cc intramuscularly or intravenously every one to two hours

Ephedrine—1 to 3 mg intramuscularly every one to two hours This may have a beneficial effect on low blood pressure

Strychnine—2 to 10 mg subcutaneously every two hours (contraindicated in morphine poisoning)

Picrotoxin—This is probably the best drug for treatment of deep barbiturate intoxication A 1 1000 solution in saline is injected intravenously (1 cc per minute) until corneal or pupillary reflexes return The drug may be repeated if depression

deepens Overdosage may cause convulsions It should not be used in alcohol or morphine intoxication Sodium succinate may also be used for barbiturate poisoning (See chapter on Anesthesia)

c Treat for shock, if present

d General The patient should be kept reasonably warm and turned frequently to prevent atelectasis Mucus should be aspirated In view of the danger of pneumonia, penicillin may be given prophylactically Sufficient parenteral fluids should be given to assure normal urine output

In the case of methyl alcohol poisoning, much of the symptomatology is due to acidosis This may be alleviated and depression lightened by administration of alkali—20 cc of 5 per cent sodium bicarbonate—or $^1/_7$ molar sodium lactate, repeated as indicated by the blood carbon dioxide level

2 Local Anesthetics—cocaine, procaine, etc

Poisoning by these agents may be manifested by

a Sudden vascular collapse and cardiac standstill For this manifestation there is no satisfactory treatment, although the usual desperate measures, such as intracardiac epinephrine, manual massage of the heart and artificial respiration, may be tried

b Restlessness, respiratory irregularity, confusion, delirium and convulsions A rapidly acting barbiturate such as sodium pentothal is injected intravenously The injection is made slowly and stopped at the point of subsidence of hyperactivity or convulsions It is repeated if symptoms recur Wherever possible, the site of injection of the toxic agent is isolated (tourniquet) Artificial respiration may be necessary

3 Mercury, Arsenic and other Heavy Metals

a Removal of unabsorbed ingested material is of paramount importance if the patient is seen early The stomach is lavaged repeatedly Give milk or raw eggs by mouth, followed by emesis, or use these agents in the lavage fluid, particularly in the case of mercury poisoning

b The dominant feature of acute poisoning is dehydration, acidosis and shock due to repeated vomiting and diarrhea Patients require large amounts of saline solution, lactate or sodium bicarbonate solution and plasma as indicated by the hematocrit, blood chemistry and the clinical condition Ten liters of fluid during the first day may not be excessive Morphine is required for pain

c The later phases of intoxication are manifested principally by visceral poisoning in the case of mercury, uremia resulting from

renal tubular necrosis, in the case of arsenic, hepatitis, exfoliative dermatitis, etc It has been shown that the systemic manifestations of mercury intoxication may be controlled by the use of BAL (British anti Lewisite), 2 3 dimercaptopropanol This is given by intra muscular injection in peanut oil solution (2 5 to 3 mg per kg) In man successful treatment has resulted from 1 8 cc of a 10 per cent solution every four hours for two days, 1 8 cc every six hours on the third day and 1 8 cc twice daily for the next ten days This may be combined with peritoneal lavage for the simultaneous treatment of the uremic state

4 *Carbon Monoxide Poisoning*

a The symptoms result from tissue anoxia Removal of carbon monoxide from the blood is favored by a high concentration of oxy gen and hindered by any concentration of carbon monoxide in the alveolar air

b Treatment consists of the inhalation of 100 per cent oxygen or, better, 90 to 95 per cent oxygen and 5 to 10 per cent carbon dioxide to increase the rate and depth of respiration Artificial respiration may be necessary

Obviously, the patient must be removed from any additional ex posure to the toxic gas remaining at the site of the poisoning

c Blood transfusions to supply fresh red cells may be tried Usually this takes too long to be practical, since the combination of oxygen and carbon dioxide will usually remove all carbon monoxide in thirty minutes

5 *Cyanide Poisoning*

This agent is usually too rapidly fatal for any treatment, but in a rare instance, therapy may be life saving Speed is essential

The basis of treatment is the administration of nitrites to form methemoglobin, which combines with cyanide to form nontoxic cyanmethemoglobin Then sodium thiosulfate is given to convert the slowly released cyanide to sulfocyanate ion

First, 0 3 to 0 5 gm of sodium nitrite in 10 to 15 cc of water is given intravenously during a period of three to four minutes If this is not immediately available, any nitrite may be given as a stopgap, for instance, inhalation of amyl nitrite may be tried Then 25 grams of sodium thiosulfate in 50 cc of water is given intravenously over a ten minute period The procedure is repeated as the clinical condi tion warrants

Methylene blue has some activity in the formation of methemo globin, but is not as efficient as nitrites

deepens Overdosage may cause convulsions It should not be used in alcohol or morphine intoxication Sodium succinate may also be used for barbiturate poisoning (See chapter on Anesthesia)

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